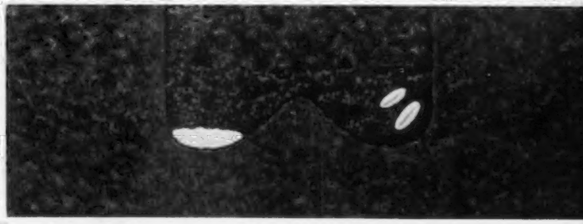
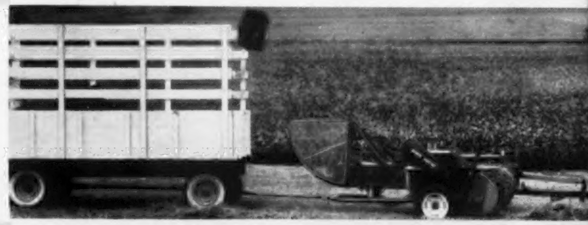
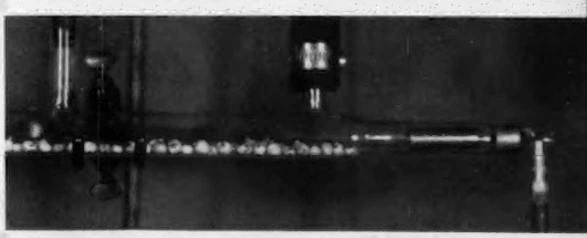
SEPTEMBER 1957

Agricultural Engineering

The Journal of the American Society of Agricultural Engineers

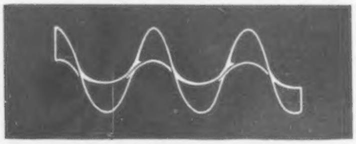




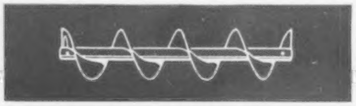


Flexible in application . . . versatile in operation

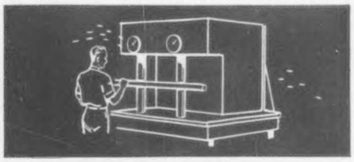
Link-Belt augers simplify design



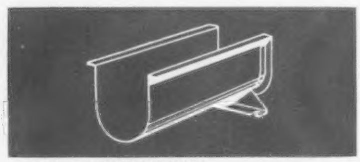
SELECTED FLIGHTING for all your auger needs. Helicoid, sectional or a range of other types of flighting are available in the metal and finish best suited for your design.



SIMPLICITY OF CONSTRUCTION and sturdy design of Link-Belt augers provide dependable, efficient operation on your machine. One basic assembly with no other moving parts to break down.

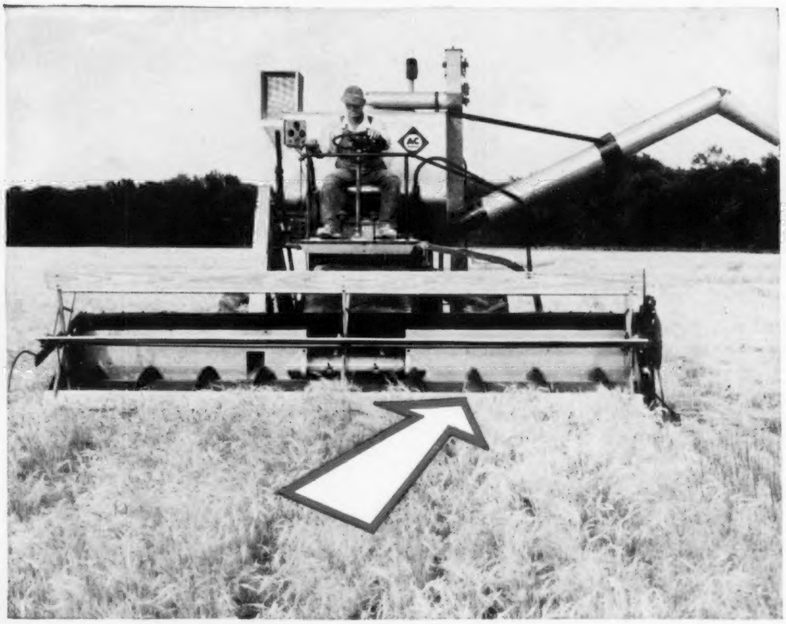


YOUR CHOICE OF METALS answers your requirements for handling corrosive or abrasive materials. And Link-Belt uses only specially selected steels to assure a uniform product.



ALL COMPONENTS — conveyor screws, collars, couplings, hangers, troughs, trough ends, flanges, drives —are available for every design.

ENGINEERING SERVICES. Our auger specialists will help you analyze your special needs . . . integrate all elements of your design.



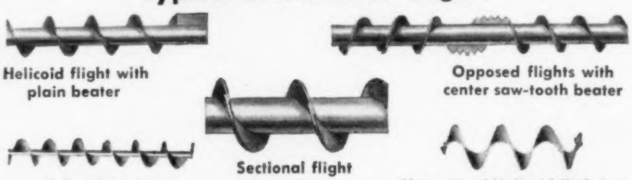
14 ft. Model A Gleaner Baldwin Combine built by Allis-Chalmers Mfg. Company, Independence, Mo. This combine uses Link-Belt screw conveyors for conveying, elevating and distributing, as well as Link-Belt chain and sprockets.

You can be sure of efficient operation, long life and low maintenance when you make a Link-Belt auger part of your equipment.

Link-Belt has a wide selection of augers, many of a specialized design, in a full range of diameters, gauges and pitches. They're accurately made to assure easy assembly, smooth, dependable operation. In addition, all components can be adapted to your particular design.

Whether it's a new application for your present machines or an entirely new concept, simplify your design problems by specifying Link-Belt augers. Call your nearest Link-Belt office for complete information.

Typical LINK-BELT augers



Helicoid flight with plain beater

Opposed flights with center saw-tooth beater

Sectional flight

Helicoid flight

Unmounted Helicoid flighting

Write for LINK-BELT Screw Conveyor Book 2289

LINK-BELT

FARM MACHINE AUGERS

14,646

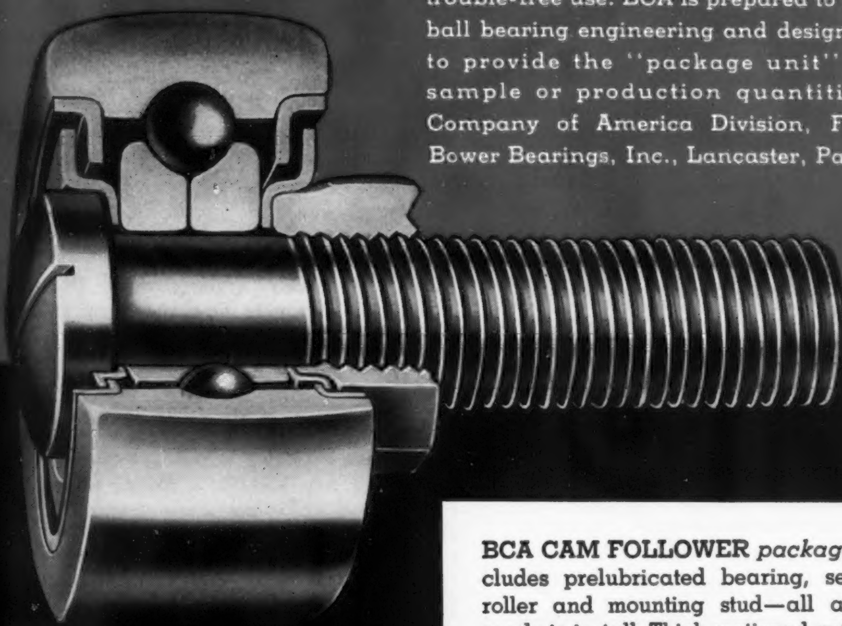
LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

For more facts circle No. 51 on reply card

BCA "package units"

. . . proven time-savers in factory and field

Design and service tested, BCA *package units* simplify production line installation . . . bring ball bearing costs down to practical levels. And rugged construction plus effective sealing assures long and trouble-free use. BCA is prepared to help with your ball bearing engineering and design problems . . . to provide the "package unit" you need in sample or production quantities. Bearings Company of America Division, Federal-Mogul-Bower Bearings, Inc., Lancaster, Pa.



BCA CAM FOLLOWER *package unit* **includes prelubricated bearing, seals, cam roller and mounting stud—all assembled, ready to install. Thick-sectioned outer race is case hardened to withstand shock and is slightly crowned to assure better contact with cam. 37 different designs available with labyrinth or contact seals to meet your "package unit" needs.**

FREE . . . BCA's "Engineering Handbook." Available to engineers without cost. Write on your company letterhead.

BEARINGS COMPANY OF AMERICA
DIVISION OF
Federal-Mogul-Bower Bearings, Inc.

For more facts circle No. 27 on reply card

Agricultural Engineering

Established 1920

CONTENTS · **SEPTEMBER, 1957** · **Vol. 38, No. 9**

Note: AGRICULTURAL ENGINEERING is regularly indexed by Engineering Index and by Agricultural Index. Volumes of AGRICULTURAL ENGINEERING, in microfilm form, are available (beginning with Vol. 32, 1951), and inquiries concerning purchase should be directed to University Microfilms, 313 North First Street, Ann Arbor, Michigan.

AGRICULTURAL ENGINEERING is owned and published monthly by the American Society of Agricultural Engineers. Editorial, subscription and advertising departments are at the central office of the Society, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700).

JAMES BASSELMAN, *Editor and Publisher*

SUBSCRIPTION PRICE: $5.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to ASAE members anywhere, $3.00 a year. Single copies (current), 50 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

. . . Energy Projected

OBSERVANCE of the Golden Anniversary of ASAE in June provided the opportunity to pause for a moment and take stock of what had gone before. A look at the past, however, often raises many questions about the future. It was fitting, indeed, that when the subject of energy and its future was to be discussed, Philip Sporn, president of American Gas and Electric Co., was given the assignment. A copy of his talk presented during the Golden Anniversary Meeting of ASAE is reproduced in full, beginning on page 657.

PHILIP SPORN

Philip Sporn was born in Austria, November, 1896, and came to the United States with his parents and was naturalized in 1907. He graduated from the Columbia University School of Engineering in 1917 with a B.S. degree in electrical engineering. He took post graduate work in 1917-18 and graduated as an electrical engineer. While attending Columbia University he affiliated with the Sigma Xi and Tau Beta Pi fraternities. In 1947 he received an honorary degree in electrical engineering from the Stevens Institute of Technology, and was granted the Docteur Honoris Causa from the University of Grenoble (France) in 1950. In 1953 he received an honorary degree from the Illinois Institute of Technology and an LL.D. degree from Hanover College.

Mr. Sporn was associated with Crocker-Wheeler Mfg. Co. in 1917-18, and the Consumer Power Co. in 1919. He joined the staff of the American Gas & Electric Co. in 1920 and has served in several engineering capacities including chief electrical engineer, chief engineer, vice-president in charge of engineering activities, vice-president and chief engineer of American Gas & Electric Service Corp., executive vice-president of both the American Gas & Electric Co. and American Gas & Electric Service Corp. In 1947 he became president.

He served as W.P.B. consultant and worked on the Oak Ridge Nuclear Power Project for the Monsanto Chemical Co. He has been a member of the Electric Power Commission, National Security Resources Board since 1947, and was a member of the Electric Utility Defense Advisory Council of Defense Electric Power Administration, 1950 to 1952.

Mr. Sporn has been awarded the National first prize in engineering practice by the American Institute of Electrical Engineers; the Edison Medal by the American Institute of Electrical Engineering; the Egleston Medal from the Columbia Engineering Alumni Assn. for distinguished engineering achievement; and the Columbia University Medal for Excellence.

He is a Fellow of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and of the American Association for the Advancement of Science. He is a member of the American Society of Civil Engineers and Franklin Institute.

Turn to page 657 for an interesting account of tomorrow's energy.

Let all these sealing engineers help you design-in oil seals

Why "do it yourself?" Why chance the wrong seal? Why risk costly retooling or remanufacture because an unforeseen condition rendered an oil seal helpless?

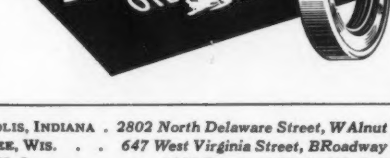
The finest oil seal counsel anywhere is yours for the asking. Just pick up the phone and call the nearest National Oil Seal Engineering office. You'll get complete, current information on newest seal developments, plus the help of the entire National Oil Seal Engineering group. Field and factory, these men devote their entire lives to seals. They have seen literally thousands of sealing problems through to a successful solution.

Let National's three decades of sealing experience help you. Call now.

Specify seals at the drawing-board stage—always!

CATALOGS Ⓢ IN SWEET'S

NATIONAL SEAL
DIVISION, Federal-Mogul-Bower Bearings, Inc.
GENERAL OFFICES: Redwood City, California
PLANTS: Van Wert, Ohio and Redwood City, California



3879

CHICAGO, ILL. . . . *Room 462, McCormick Building, HArrison 7-5163*
CLEVELAND, OHIO . *210 Heights Rockefeller Bldg., YEllowstone 2-2720*
DETROIT, MICH. . . . . *13836 Puritan Avenue, VErmont 6-1909*
INDIANAPOLIS, INDIANA . *2802 North Delaware Street, WAlnut 3-1535*
MILWAUKEE, WIS. . . *647 West Virginia Street, BRoadway 1-3234*
NEWARK, N. J. . . . . . *1180 Raymond Blvd., MItchell 2-7586*
DOWNEY (Los Angeles County), CALIF. . . *11634 Patton Road, TOpaz 2-8163*

For more facts circle No. 11 on reply card

For more facts circle No. 9 on reply card

 For more facts circle No. 46 on reply card

Report to Readers . . .

NEW MATERIALS KEEP DESIGN ENGINEERS ON THE QUI VIVE Small wonder that farm equipment manufacturers have in recent years been assigning specialists in their engineering development and design departments to materials research and standardization. These days design engineers find themselves constantly confronted with many new and improved materials. And not only are the different kinds of materials increasing, but they are at the same time undergoing continual improvement. These include not only the metals, but also the plastics, rubbers, etc. The choice of the best all-around material for a certain application becomes an increasingly difficult problem - not the least important aspect of which may be the factor of obsolescence, since the whole materials picture is in a constant state of flux. . . . The canny design engineer, however, is not likely to be the first to specify a new material, nor yet the last to discard one that has become outmoded. Constant alertness is the price of keeping up with the fast-moving materials procession.

FARM ANIMALS AS OFFENDERS IN CAUSING COMPACTION OF SOIL While engineers of the farm equipment industry and of state and federal agricultural research agencies have been genuinely knitting their brows over the problem of soil compaction resulting from the use of heavy farm machines, a University of Wisconsin soils specialist has been analyzing measurements on soil structure under conditions of grazing, green feeding and hay or silage harvesting. He has found soil compaction to be greatest on grazed land and least on land where forage was cut by machinery for stored feed. Areas with the least traffic of course showed the least amount of compaction, and grazing cattle caused the most, while twice-a-year use of machinery caused the least. . . . Next step in the Wisconsin study will be to measure crop losses resulting from compaction. . . . So engineers may take some small comfort at least in the fact that field equipment, product of their efforts, is not the sole offender by a long ways in causing soil compaction.

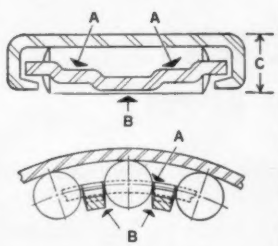
INDICATION OF FUTURE TREND OF INTEGRAL-SEAL BALL BEARINGS Just a hint of interest to design engineers as to the future trend of integral-seal ball bearings was gleaned from an article on the subject in the July-August-September, 1957, issue of "General Motors Engineering Journal," by two engineers of the New Departure Division of GMC, M. T. Monich and C. T. Bragdon, and this indication is briefly stated by the authors as follows: "From the seal builder's standpoint, the trend is toward a single, all-purpose seal. While recent developments in design and material accomplish this objective to a limited degree, the ideal seal is envisioned as being effective for all types of contaminants and under all operating conditions. Furthermore, the seal should last as long as the bearing and be inexpensive to produce." . . . . The authors conclude their article on an efficiency note: "To improve the efficiency of the integral seal, it has been found necessary to improve its precision. This has been accomplished by a relatively low-cost molded sealing element made from synthetic rubber. Designs using the molded construction satisfy other requirements recently brought into prominence, namely: (a) the seals can be removed and replaced, (b) bearing-ring distortion is kept to a minimum, and (c) seals are not loosened by exposure to severe vibration."

AUTOMATION GETS PUSH TOWARDS FARM WITH ONE-MAN HAY MAKING Last month one of the leading builders of farm equipment (Deere) announced a new one-man system for baling and storing hay, which it justifiably claims as "a giant stride in materials handling on the farm." In fact, it makes one-man haying a reality, since the mowing, tedding and raking operations have long since been one-man jobs. . . . The newly announced Deere system includes only the baling, loading, and storing operations. A twine-tie baler behind the tractor picks up and makes half-size bales from the windrow, and a bale-ejector attachment on the baler tosses the bales into a wagon with high sides trailing the baler. When hauled to the barn for storage, the bales are dumped into the general-purpose hopper attachment of an elevator and delivered to a bale conveyor hung from the ridgepole in the barn. The conveyor discharges the bales to either side at ten-foot intervals. No stacking of the short bales in the mow is necessary. While storage space is reduced about 10 percent, at the same time adequate air circulation around the bales is provided. . . . What makes this system a great advancement in handling hay is the extent to which it saves labor. On one large dairy farm the labor force used in their baling and handling operations was reduced by seven men. The system does away with the back-breaking work of handling bales and speeds up the haying operation generally. Another thing, better hay in the barn, both easier to handle and to feed, is assured.

PICKER-SHELLER AND MECHANICAL DRIER CAN REDUCE CORN HARVESTING LOSSES That is the conclusion reached by engineers at the Minnesota Agricultural Experiment Station as a result of their tests in recent years. If both the picker-sheller and drier are used, the corn can be harvested earlier; and with early harvesting the corn loss is less. In general, the engineers found that the higher the moisture content of the kernels at harvest time, the lower the total harvesting loss. In one year's test, this loss was slightly more than 4 percent in the case of 30 percent kernel moisture corn and about 7 percent loss at 26 percent moisture later in the season . . . . Based on these tests the Minnesota engineers say that farmers using the picker-sheller-mechanical drier combination can start harvesting when the kernel moisture of the standing corn has reached 26 percent, and for feed grain at about 28 percent moisture content.

NEW USE OF PLASTIC SHEETS IN PRESERVATION OF FORAGE One of today's new products which has astounding possibilities for use in farming is the plastic sheet, one important use being for forage preservation, particularly of silage, and in connection with conventional storage systems. . . . But here's a new innovation of the preservation idea, developed at the Minnesota Agricultural Experiment Station, that has much to commend it, especially since it makes possible forage of high quality and good palatability. It is low-moisture, baled grass silage. After the grass is cut, it is allowed to wilt to a moisture content of about 40 percent. Then it is baled, the bales are stacked on one end of a plastic sheet, and the loose end of the sheet is pulled over the bales and stapled. The silage is therefore airtight and is said to be similar in quality to that stored in sealed vertical silos. . . . The new system has these advantages: it simplifies harvesting, does away with most of the spoilage, and makes for easier handling of the silage. And not least in importance, animals find it more palatable.

Features of the new
TORRINGTON DRAWN CUP ROLLER BEARING



- rollers end-guided at pitch line (A)
- shaft-riding retainer (B) designed to permit lubricant circulation
- high capacity in small cross section (C)
- long pregreased life
- efficient at high speeds
- mounted by press fit
- simple housing design
- low unit cost

INTRODUCING

a new low-cost precision roller bearing...

THE TORRINGTON DRAWN CUP ROLLER BEARING

For the first time, the advantages of drawn cup outer race construction are available in a precision roller bearing.

This compact, lightweight bearing consists of spherical end needle rollers, a one-piece hardened steel retainer and case-hardened thin-section outer race. Designed to run on a hardened shaft or with an inner race, this new series takes a press fit in a simple housing without snap-rings or shoulders.

Highly efficient roller guidance and lubrication are outstanding features. The shaft-riding retainer contacts the roller ends at the pitch line where guidance can be obtained with the least effort. The design provides ample storage for lubricant and promotes its circulation.

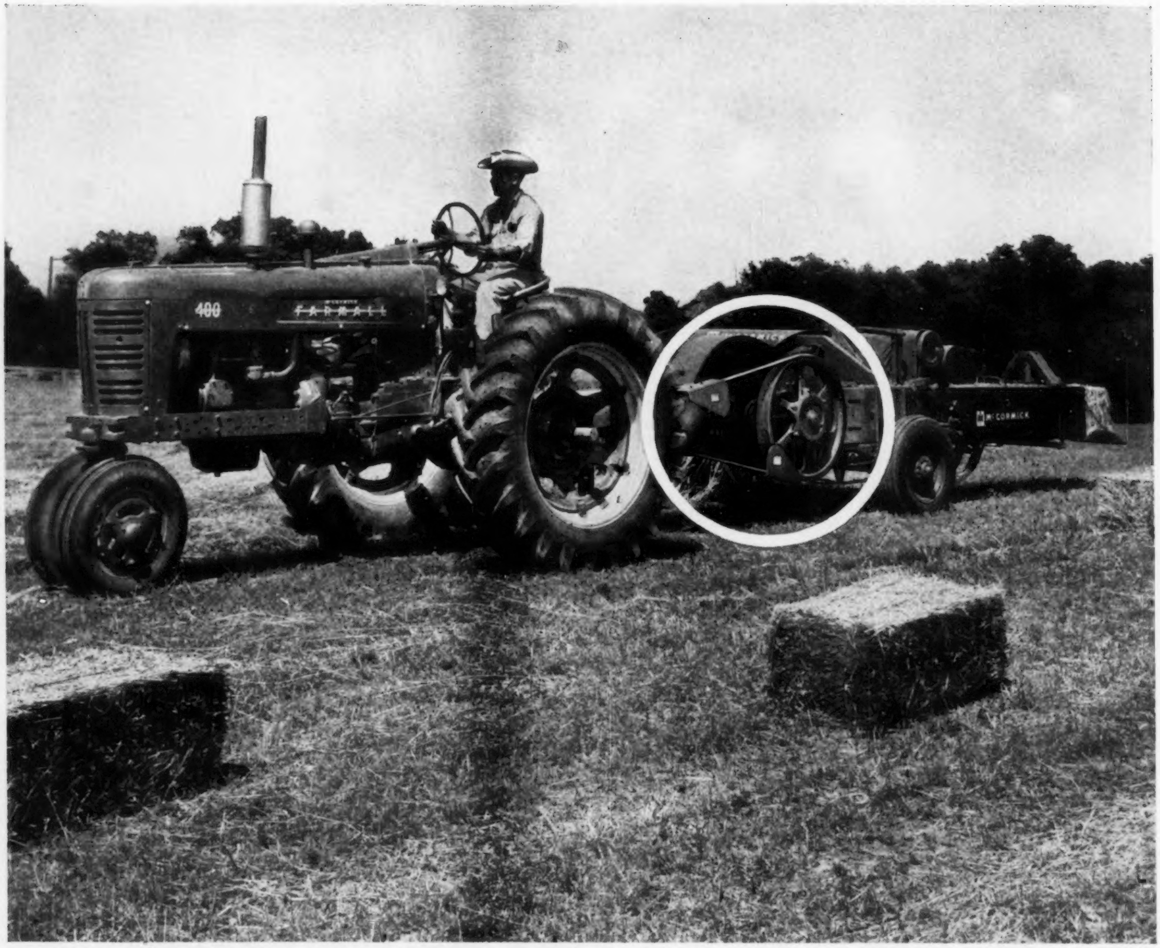
These features make the new bearing particularly suited to applications requiring compactness with precision, high-speed endurance or long pregreased life.

For information on sizes now available and for application assistance, call on our Engineering Department or write for the new bulletin, "Torrington Drawn Cup Roller Bearings." The Torrington Company, Torrington, Conn. — and South Bend, Ind.

TORRINGTON BEARINGS

District Offices and Distributors in Principal Cities of United States and Canada

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • THRUST • BALL • NEEDLE ROLLERS



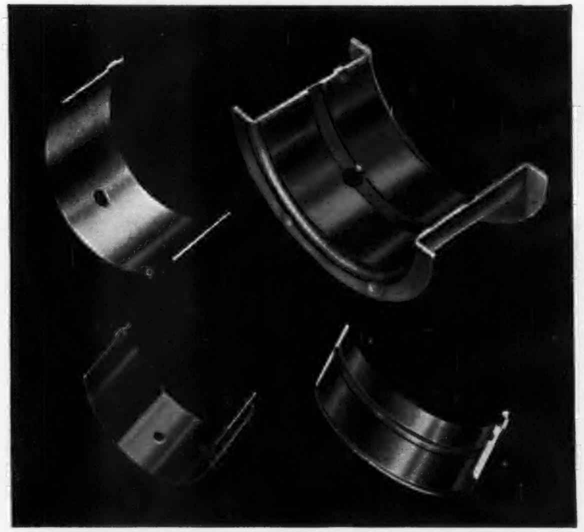
 For more facts circle No. 45 on reply card

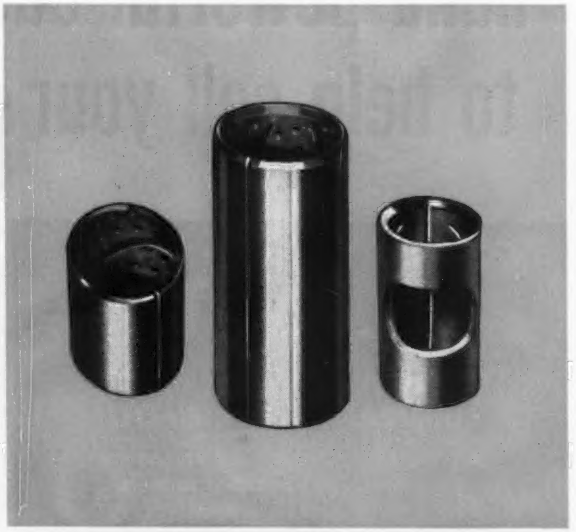
Three alloy linings meet 95% of engine bearing needs

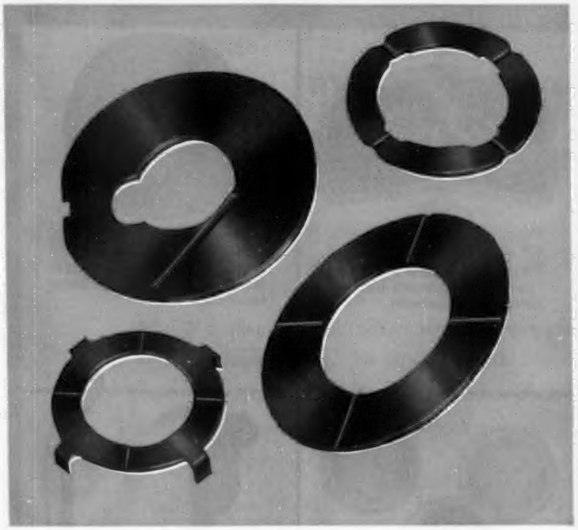
Experience shows a steel back lined with tin- or lead-base babbitt or copper-alloy meets performance requirements.

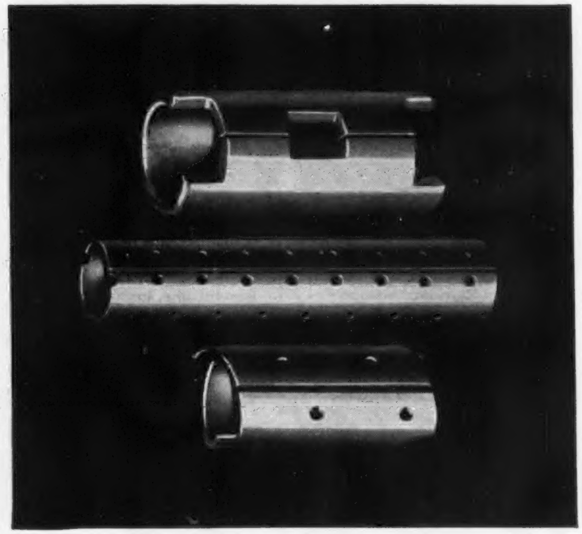
Bimetal and Plain Bushings offer substantial economies

Rolled split plain bronze, steel or aluminum; or steel lined with bronze, babbitt or copper-alloy. Many design variations possible, plus volume production economies.









Precision Thrust Washers in Bronze or Bronze on Steel

Cold rolled for heavy duty. Steel faced with copper-alloy on one or *both* faces. Nibs, lugs, coined oil grooves. Flat, spherical or special shapes. From 1" to 6" O.D.

FEDERAL Mogul SINCE 1899

Economical Spacer Tubes for Hundreds of Applications

Money-saving substitute for iron pipe, tubing or machined parts. Delivered ready for assembly, to exact dimensions—or can be brazed to other components.

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11081 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

For more facts circle No. 15 on reply card

TWO GREAT NAMES IN ORIGINAL EQUIPMENT...

build powerful customer preference to help sell your farm implements!

ALEMITE

WORLD LEADER IN LUBRICATION EQUIPMENT

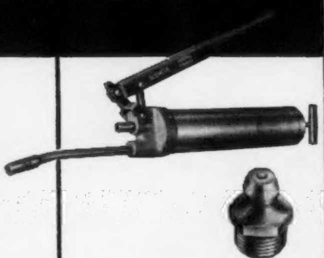
A complete line of proved equipment for every purpose . . . that farmers buy — and know best!

STEWART-WARNER

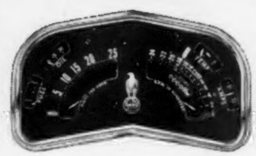
WORLD LEADER IN INSTRUMENTS AND GAUGES

All types, including complete drive equipment . . . designed, engineered and manufactured to your specifications!

Big-A Bucket Pump
For light or heavy lubricants. Standard equipment on many leading makes of tractors and crawler equipment.



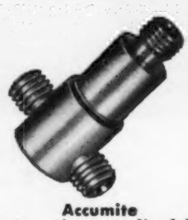
"RFD" Hand Gun and Red Ball Fittings
Big-volume, high-pressure delivery. Standard equipment on leading makes. Armorhard fittings for every purpose.



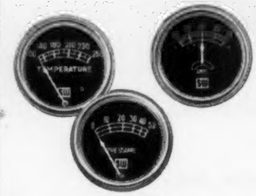
Custom-built Panel
Complete instrument "packages" custom-built to your specifications.

Tractor Tachourmeter
Developed by Stewart-Warner especially for farm tractors.

Surgepruf Hose and Couplings
Complete line of hose and components for every hydraulic use...medium-high and high-pressure service.



Accumite
Automatic centralized lubrication. No limit to number of bearings served. For corn pickers, combines, grain drills.



Gauges
Only Stewart-Warner offers *all* types: Bi-metal, Magnetic, Diaphragm, Bourdon Tube.

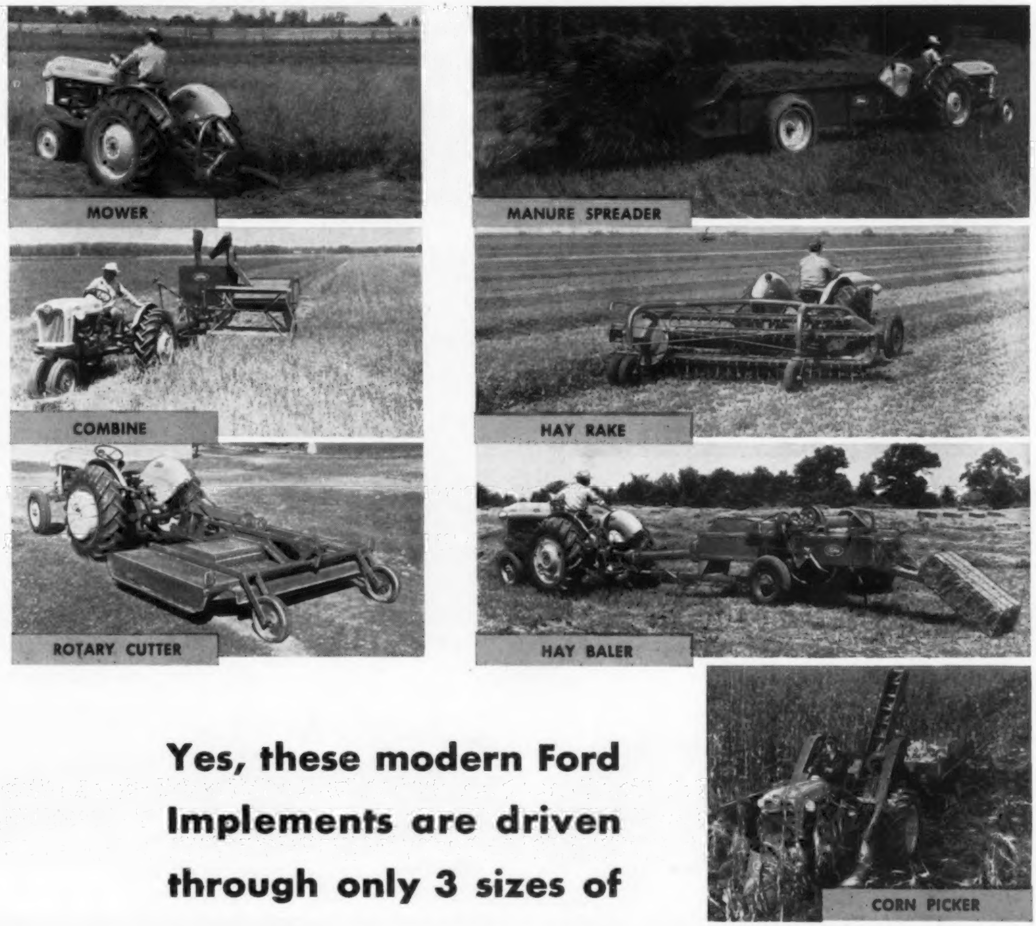
Hardware
Includes all types of hood catches, fasteners and brackets, handles.

For further information, write **STEWART-WARNER**

STEWART SW WARNER

Dept. V-97, Original Equipment Sales • 1826 West Diversey Parkway, Chicago 14, Illinois

For more facts circle No. 49 on reply card



Yes, these modern Ford Implements are driven through only 3 sizes of

BLOOD BROTHERS UNIVERSAL JOINTS

You'll find important advantages in equipping your implement line with fewer different parts. By working with Blood Brothers' engineers, you can enjoy cooperation to help reduce initial costs and minimize your own engineering expense. Purchasing, stocking and parts cataloging problems, too, are simplified.

And because Blood Brothers Universal Joints deliver the trouble-free, long-lasting service farmers expect, your implements have maximum sales appeal.

Be sure you get the advantages of Blood Brothers engineering, performance and prestige . . . write for full information.

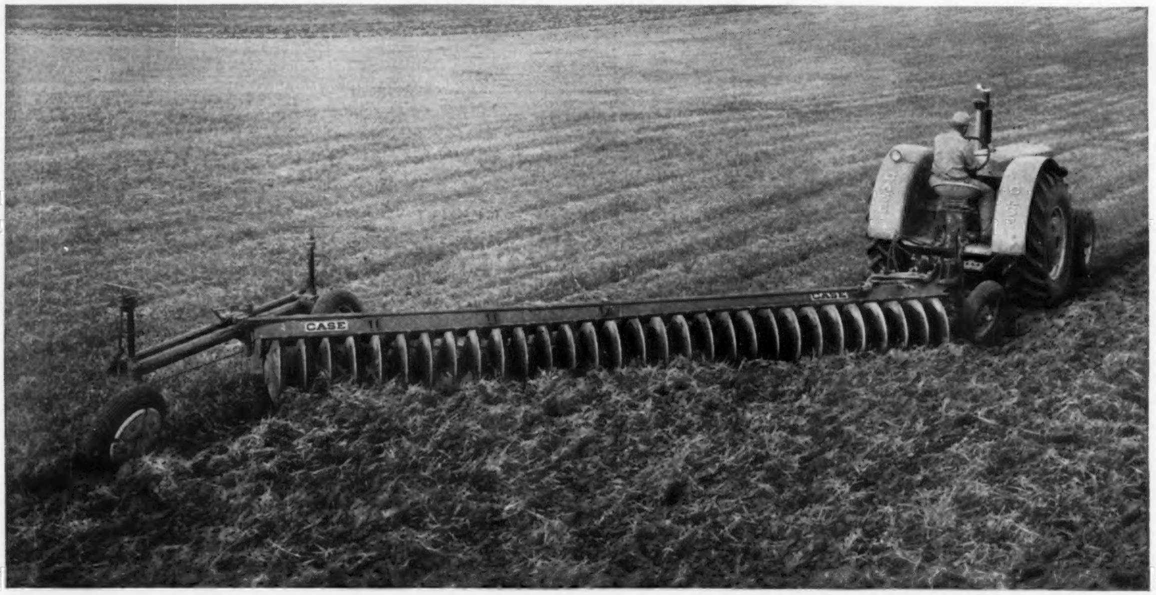
FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED

TAKES POWER AROUND CORNERS

BLOOD BROTHERS
MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

For more facts circle No. 22 on reply card



Plowing an ACRE in 6 MINUTES with Ingersoll Discs

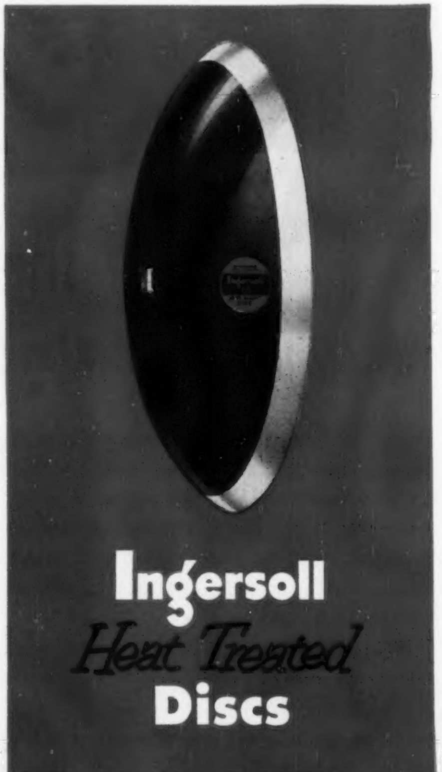
Big-acreage farming calls for big equipment like the Case "W" 18-foot, 30-disc plow shown above. It's made for the wheatlands and its job is to turn under and chop up tough stubble, leaving enough residue to absorb moisture and check soil blowing.

J. I. Case uses big, tough Ingersoll discs as original equipment on this and other tillage implements as do *all* leading farm equipment manufacturers. They've found that Ingersoll discs are built to do the job right and take the brutal shocks of modern farming without splitting, curling or warping.

One big reason is TEM-CROSS® steel. Made only by Ingersoll, it's a special tillage steel that's cross-rolled to stand enormous stresses and heavy impact. It's heat-treated, too, by an exclusive Ingersoll process to give it just the right combination of hardness and springiness.

It's good business to use Ingersoll discs whenever you make replacements. They're available direct from your implement manufacturer and they're sure to win customer satisfaction.

Case 383-H Offset Harrow with Ingersoll Dura-Notch Discs



INGERSOLL PRODUCTS DIVISION
Borg-Warner Corporation, Chicago 43, Illinois
EXPORT SALES: Borg-Warner International, 36 S. Wabash, Chicago 3

SPECIALISTS IN TILLAGE STEELS
WORLD'S LARGEST MANUFACTURER OF DISCS

THE ONLY MANUFACTURER OF DURA-DISC—THE STEEL THAT IS THE ECONOMICAL REPLACEMENT FOR HIGH-COST ALLOYS

Agricultural Engineering

September, 1957
Volume 38
Number 9

James Basselman, Editor

Energy Requirements

and the Role of Energy in Our Expanding Economy

Philip Sporn
President, American Gas and Electric Company

Address presented during a general session at the Golden Anniversary Meeting of the American Society of Agricultural Engineers, East Lansing, Mich., June, 1957.

IN RECENT years there has been a growing awareness of the need for looking ahead into the future and planning for the longer term in many facets of our economy. This long range thinking is very important and necessary if we are to maintain our national safety and our standards of welfare. In basic research it is particularly necessary to be aware of the need for taking a long-term view. Over the next 25 years we will be applying in a practical way the results of basic research begun 25 years ago and, in many cases, much earlier.

We cannot wait until the problems are upon us to seek a solution. The problems of the future must be anticipated and fundamental work begun, even if only in broadest outline, well in advance.

There are three futures. The immediate future, say of the next 25 years; that of the next 100 years; and the future beyond that. I would like to discuss with you our energy requirements in the next 25 years. The next 100 years can only be discussed in very general and sketchy terms. The future beyond that falls into the realm of fantasy which I shall completely ignore.

There are those neo-Malthusians who envision the inevitable depression of our levels of welfare because of excessive population and the depletion of our natural resources. They imply that we have perhaps already reached or will soon attain the peak of human welfare from which there can only be decline. Without underestimating the importance of the fundamental numbers: resources, or man-to-land ratios, I still must reject this unqualified pessimism. I cannot believe that succeeding generations will lack the genius to continue to build on the foundations of the past and so contribute their share to the attainment of higher levels. Of course assuring the continued availability of raw materials and energy will be a problem. But always man has found new materials, new resources. It is impossible to believe that this process will not continue beyond our present stage of civilization. The question is how much time is available to develop these new resources.

Energy Resources and Use Rate

Our energy resources are a particularly good case in point. We advanced from human muscle to animal power, to wood, to fossil fuels, and now are verging on an age of atomic power, just as in other areas we have developed new materials to replace exhausted supplies of established resources.

One of the characteristics of energy use in any technically advancing society is that the rate of growth of energy use is considerably higher than the rate of growth of population and closely parallels the growth of economic output; this is true in the United States. From 1900 to 1956 population grew almost 2¼ times from 76 million to 170 million while energy use grew from almost 8×10^{15} Btu to over 42×10^{15} Btu or over 5¼ times. This represents a growth from 320 million tons of coal per year to 1680 million tons of coal equivalent. Btu consumption per capita grew from slightly over 100×10^6 Btu to just over 250×10^6 Btu or 2½ times.

During this same period there has been an irregular downward drift in energy consumption per real dollar of Gross National Product. The almost 7-fold increase in GNP since 1900 has been accompanied by a decline of energy use per dollar to about 78 percent of the 1900 figure. However, this has resulted from giant strides in the efficiency of application of energy to production as, for example, in the reduction of fuel requirements in electric power generation from about 6.8 lb of coal per kwh to 0.9 lb. If, over the same period, we were to measure energy in terms of useful work the decline per dollar of GNP would disappear and show up as a substantial increase.

Since the material presented by Mr. Sporn during the Golden Anniversary Meeting of ASAE is of vital importance to all engineers, the address is reproduced in full for those who were not privileged to hear it at that time. Biographical sketch of the author appears on page 640.

In view of the rapidly expanding need for energy, the problems raised by the exhaustion of older resources and the emergence of new resources which are focusing attention on the energy problem, it is now more important than ever to take a hard, clear look at all the elements of the energy picture and to anticipate the problems likely to confront us so that we may meet them effectively. It is especially important to examine the first of the three futures I cited — the more immediate future of 20 to 25 years — a period in which most of us will have an active responsibility.

Future Requirements

I shall discuss the two different time phases of the energy picture somewhat differently. For the next 100 years I shall merely identify and only briefly develop a number of problems and questions. For the shorter period of 20 to 25 years I shall speak in more detail especially about electric power.

The two time periods are closely related and represent a distinction only in the degree of urgency. The developments of the next quarter century must necessarily have their impact on the succeeding hundred years. The ability to make decisions and implement plans necessary in a 5 or 10-year period hinges upon whether the problems to be solved in detail had been visualized, even if only amorphously, 20, 30 or more years earlier and a beginning made in seeking answers to fundamental questions. Despite the apparent rapidity with which technological changes are taking place in our present society, a closer scrutiny reveals their seeds sown much earlier.

(Continued on page 677)

Engineering Problems in Fertilizer Placement

Harry B. Walker
Honorary Member ASAE

This report on a pressing need for the development of better fertilizer placement machinery, points out the problems design engineers must face

FERTILIZATION of farm crops is based upon the crop requirements, which must be supplied by the soil plus such additives from other sources as may be specifically needed. We might say then, that crop fertilization equals soil fertility plus fertilizer additives, or the fertilizer to be applied equals the crop requirements minus the fertility supplied by the soil.

The simplicity of these relationships is apparent, but their specific value is questionable since all of the factors are variables depending upon the type and character of the crop, its climatic environment, and the nature of the soil that supports it. Thus, when attempting to solve the engineering problems of crop fertilization, the engineer becomes somewhat helpless without the cooperation of the soil scientist, the agronomist, the plant nutritionist, and others interested in the basic agricultural sciences. Fortunately, these have proven to be willing cooperators, and it depends upon teamwork with these for real engineering achievement in solving the problems of efficient and economic placement of agricultural fertilizers.

Objectives

There is some divergence of thought as to what the specific objectives are in fertilizer application. Most approach the problem from the view point of supplying the crop with adequate nutritive elements. Others think of the soil as the storehouse for plant nutrients and out of this emerges the concept of fertilizing the soil rather than a specific crop. These differences in concept are unimportant with reference to placement, except perhaps as to the degree of fertilization for the greatest economic returns.

It is apparent in these days of emphasis on farm management that economic efficiency is being sought. Since the measure of crop return determines the profits, it is not illogical to think of this as crop fertilization. On the other hand, the soil is the media for plant growth, and in this respect is considered as the fertility storehouse. It is the response of economic plants, however, that reveals to us most readily the success of fertilization methods. For this reason the specific needs of the plant have a great influence on specifications for fertilizer placement.

The why, what, where and when of fertilizer application are largely the problems of the engineer's biological associates. The soil scientist determines the soil fertility potential, and from this is determined the additives needed to bring the fertility level up to the economic requirement for a particular crop. The agronomist and plant nutritionist have the responsibility of determining the proper dosage and proper placement of additives as well as the optimum time for application.

These determinations are of great help to the engineer, who must devise the ways and means of carrying out these specifications. The engineer's problem, however, is complicated not only as to these basic requirements, but also by the various forms of materials available to supply the nutritive needs. The chemical industry is both a young and dynamic one, made so largely by its acknowledged dependence upon research. No other modern commercial industry spends so much of its sales money on scientific investigations. Perhaps this accounts for its status as a growth industry. The following quotation comes from a recent issue of the *Financial World:* "Chemical makers(1)* account for over 20 percent of all the research dollars spent by private industry in the United States, though chemicals and allied products represent no more than 6 to 7 percent of total industrial output."

This research leadership upon the part of the industries supplying fertilizer materials tends to create a rather volatile situation for the suppliers of application equipment. In addition to the various forms and combinations of nitrogen, phosphorus, and potassium there are various micro-elements, as well as mixture combinations sometimes including pest control chemicals. These materials are available in the form of dusts, granules, pellets or liquid and gaseous forms, the latter including both pressure and non-pressure types. These material forms introduce a wide range of application methods such as dry, liquid, high pressure, low pressure, no pressure, surface and sub-surface applications, air-borne systems, irrigation water methods, spray applications and the like.

These factors are mentioned to point out that a rather volatile situation exists as to the physical state of the materials making it difficult for design engineers of applicators to firm equipment developments to obtain volume output. This is a handicap to implement concerns, which supply a national market. It offers little in the way of direct profit motives for specific apparatus which involves tooling costs, and introduces hazards due to early obsolescence threats.

Fertilizer Prescriptions

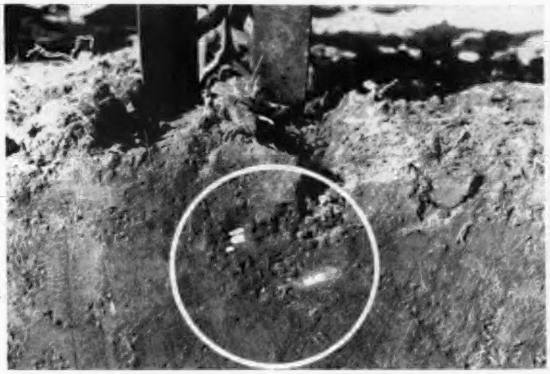
There are hopeful signs, as expressed by Shaw(2) in recent crystal-ball gazing observations: "If the research (now underway) were successful, the farmer would have simple, easy-to-use ways to measure fertilizer and water needs for a crop. This would enable him to predict yields with great accuracy. More than that he would be able to adjust the rate

*Numbers in parentheses refer to the appended references.

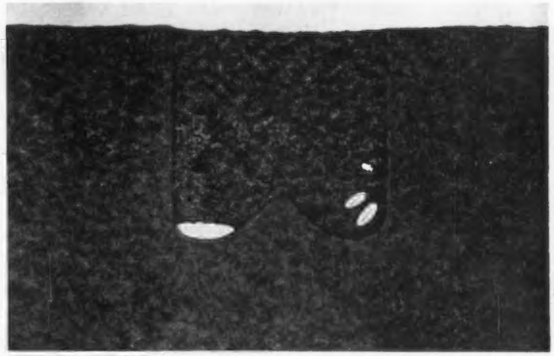
Paper presented at the winter meeting of the American Society of Agricultural Engineers at Chicago, Ill., December, 1956, on a program arranged by the National Joint Committee on Fertilizer Application.

The author—HARRY B. WALKER, deceased—was professor emeritus of agricultural engineering, University of California, Davis.

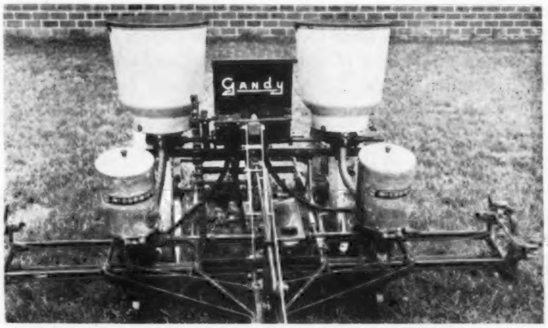
Recent Developments



Deere and Co. recently introduced a new fertilizer disk opener for putting either dry or liquid fertilizer in a single band 2½ in to one side of the seed and at any depth from level with the seed to 1¼ in below the seed



(Above) Allis-Chalmers Mfg. Co. used this illustration to show how their mounted grain drill deposited fertilizer deeper than the seed and to the side • *(Below)* International Harvester Co. has announced that a granular chemical attachment for their planters will be handled by IH dealers (see page 684). The attachment is manufactured by E. S. Gandrud Co. Inc.



of application to a cost that would be profitable under existing prices. Fertilizer prescriptions would be based on a clear understanding of the nutrients, and the plant's ability to make use of them. A single application would provide the fertilizer throughout its life."

The last line of this quote is of particular interest to engineers, and to farm managers. A single application for complete crop fertilization surely would require some firming of the materials as to form, as well as to the method of placement. If fertilizer prescriptions to be used in a single dosage is in the future, many of the vexing problems of application now confronting engineers should be simplified. If prescription fertilization should develop on a broad scale, it should be possible also to compound the prescription into forms suitable for exacting applications.

At present there is more general acceptance of application methods for dry fertilizers than for some of the newer liquid types. However, there is as yet no recognized standards for a modulus of uniformity or fineness for these dry forms. They may be fine, granulated or roughly pelleted. Dry forms of fertilizer may be applied readily by surface or air-borne equipment. It is assumed in this discussion that materials dissolved in water before application are liquid types. If it were possible to pelletize these dry forms into particles having a uniform size and shape, and to include in the dosage enough fertilizer in the required elements so as to be available to the plant for an entire season, a tremendous contribution would be made to better and less costly management. It would afford also a potential for more accurate placement by mechanical methods. These concepts perhaps represent the ideal approach, which, of course in practice, must be modified to conform with sound economics. However, before the idea is brushed aside as visionary and impractical, some of the basic advantages should be considered.

Pelletized Fertilizers

First, from the engineering viewpoint, let us assume combinations of nitrogen, phosphorus, and potassium could be made up into spherical pellets of uniform size. In this form they could be readily and accurately metered through plates, or cups, to provide a large range of placement rates. Likewise, this placement could be accurately made with reference to the seed and the potential root zones of plants at high travel rates due to the uniform size and weight of the pellets. Such a form of material would be highly adaptable to surface equipment and by proper formulation of the pellet ingredients, it is reasonable to assume that dosages could be so placed that less of the basic ingredients would be needed quantitatively for a given crop objective. Should this be possible, a goodly proportion of the overall savings could be put into the processing with the potential profits to the consumer realized through the new field placement efficiencies obtained. The advantages of accurate placement and uniformity of distribution should be reflected in better plant response, and also in a saving in production management, due to more dependable machine elements, and some reduction in weight of the materials handled. If such a material form could be made complete enough for a one-shot dosage, then savings in both field travel and application costs could be realized. With present application methods by ground supported equipment, field travel is great enough to cause some concern about soil compaction. The pellet form would be exceptionally well adapted for application with air-borne equipment since the specific gravity of the pellets would offer greater resistance to wind drift and the coarser ma-

. . . Fertilizer Placement

terials would reduce corrosion hazards to the plane's parts. Air equipment could be used with greater efficiency, not only for rice and other wet surface crops, but for surface placement on pastures and range land during seasons when normal surface equipment could not be used advantageously.

This concept places a further responsibility on the dynamic chemical industry. However, it is now supplying mixed fertilizers in various forms, and in recent years, it has greatly improved the physical characteristics of the dry forms. Non-uniform pelletized products are now being manufactured. Not being a chemical engineer, it is easy for me to overlook the technical details to be overcome in manufacturing uniform sized pellets. However, the progress already made, and the great wealth of technical talent the industry now possesses encourages the thought that some phases of this idealism for dry forms of fertilizer may be near.

Dosing Irrigation Water

The fertilizer industry has contributed much to the introduction of liquid forms of commercial fertilizers. Their research with placement equipment is highly commendable even though it has been confined in most cases to particular products. The dosing of irrigation water has become a recognized practice in the Far West, particularly for row crops watered by furrow irrigation methods. Since water application is a must for these areas, it is both logical and economical to use water as the vehicle to carry plant nutrients to the crop. To do this economically and properly by surface irrigation methods requires a proper balance between head of water, length of run, and dosage method. If the irrigation method is efficient in its water distribution to the crop, then fertilizer distribution through the irrigation water is equally effective. This is well worked out in the more highly developed irrigation areas, where adequate land preparation is recognized as a necessity for economical water spreading.

In recent years irrigation by sprinkling has become widespread, and it continues to expand in all parts of the nation where sufficient water is available. Users of irrigation sprinkler systems are interested in utilizing them for the distribution of fertilizers, because they offer attractive potentials for savings in time, labor and equipment costs. Since the water is delivered under pressure, a charger tank is necessary to introduce the liquids into the system. Due to corrosion hazards, special spreading techniques are used, as well as to create favorable crop environments. For example, in a given set, the first quarter of the set may be operated with clear water, the second quarter charged with the fertilizer, and the last half of the set run with clear water. Thus, the method becomes in a way self-cleaning and the danger of foliage burn is overcome. This type of application is especially well adapted to solid plantings and encouraging results have been obtained from some row crops like potatoes. Certain forms(3) of nitrogen fertilizers which contain ammonium ions (NH_4^+) also contain free ammonia, which is subject to loss through volatilization. Aqua ammonia, for example, is not a suitable form for this reason. Also the pH of the solution is a factor, and this depends both upon the characteristics of the water and the fertilizer materials. The pH of the applied solution should be kept as near neutral as practicable.

Gaseous Fertilizers

The use of anhydrous and aqua ammonia is growing rapidly, particularly in the West, and it is spreading to all agricultural areas. Such forms offer attractive advantages with reference to net cost of nitrogen, but there are problems of distribution and placement which need further study. Generally, these materials are placed below the surface, and for this reason they become most effective for placement in soils previous to the planting of solid crops. The techniques for row crop applications such as band placement are not fully developed. Lorenz and his colleagues(4) report plant injury from the application of anhydrous and aqua ammonia to row crop vegetables, which did not occur from the comparable use of ammonium sulfate, ammonium nitrate and similar dry fertilizers. There were significant differences in yields of onions and potatoes. They accounted for the crop losses as a result of the wider spread of the gaseous forms through the soil. In certain of the light textured soils, ammonia from the liquid applications moved twice as far from the point of application as ammonia from ammonium sulfate.

Corrosion

The problems of corrosion, in addition to proper metering from containers, loom large in equipment development for the placement of liquid fertilizers. Carbon steel is attacked by most of the nitrogen solutions, and aluminum is corroded by presently available complete fertilizers. Merrill (5) very ably pointed out these problems in his recent paper on fertilizer application equipment.

In reviewing the fertilizer placement problems confronting agricultural engineers, it appears that a careful inventory should be made of all of the development factors. This includes the materials as to form in addition to others. Probably, aside from the increased consumption of high analysis fertilizer of all forms, the most dynamic factor is the greater emphasis now placed on farm management. The modern up-to-date farmer must know how to use land, water, capital and equipment. These are factors which also influence the use of fertilizers and management's appraisal of production equipment. The farmer seems not too well satisfied with the equipment he uses with his tractors. The use of fertilizers in a farming program places emphasis on rate and timeliness of applications. More and more, the farmer is concerned with the optimum time for field work. He waits until soil conditions of both temperature and moisture are correct for such things as seeding operations, and then he wants to proceed at an uninterrupted rate to complete these during this optimum period. Machine outages during such periods are costly and equipment which does its functional operation only "after a fashion" may result in repeat operations, and often, loss of crop yield. These factors are particularly important in the application of fertilizers.

The trend being toward more concentrated formulations these materials become too expensive to misuse, or to waste. While it seems hopeful that single dosages for a complete crop will become available eventually, this is not yet considered practical for nitrogen applications to row crops. Currently, timely application by increments is practiced. Under these conditions the careful farm manager becomes vexed with equipment outages and he hopes to avoid them. First cost of placement apparatus has been, and still is, a big factor in the thinking of both consumers and suppliers.

Looking ahead, it would appear that it is time to appraise initial cost more in line with dependable function.

Dry fertilizers, applied by surface methods and liquid fertilizers applied through gravity irrigation water, are the best stabilized in regard to application practice. These application methods are basically sound for most regions of the United States, but refinements are desirable. Surface irrigation is not practiced to any great extent except in the western states. Throughout the nation, sprinkler irrigation is expanding. Where such systems are used for fertilizer placement, more restrictive and less stabilized practices are involved. The pH of the water and the quantity and characteristics of the plant nutrients applied become influencing factors.

Solid Crop Plantings

The problems of pre-plant applications for solid crop plantings are quite well established as to method for both dry and liquid forms. The dry formulations are better adapted to smaller operations than the application of the volatile and liquid types. As to general type of equipment, however, there is reasonable agreement. With the volatile formulations, sub-surface placement is essential at considerable depth with subsequent firming of the surface. This requires heavy equipment of a rather special nature not readily supported on average or below sized farms. The contract, or custom service, now available in the West is proving to be popular for the application of anhydrous ammonia. For grain, forage crops and pre-plant applications for pasture seedings, sub-surface placement is generally followed. There is a growing tendency to use surface applications of both wet and dry forms for post-seeding applications to pastures and meadows. Fall placement is growing in importance and has many advantages from the standpoint of management.

Row Crops

Row crops become increasingly important with growing competition for agricultural land areas. It is in such crops that accuracy and timeliness of placement are most rigid. While most of the band placement of fertilizers is to the side and below the seed area, this is not to be accepted as a generalization. The plant, its needs, form of applied nutrients, climatic and soil conditions are so variable that continuous, detailed and repetitive research programs are essential to establish safe economic practices in the various sections of the United States. There is a great need for more specific recommendations from Agricultural Experiment Stations particularly in matters relating to band placement. Furthermore, the results of such research need to be carried promptly to the farmers through efficient extension methods.

Application Equipment

Application equipment must be kept up to date. It has been hazardous to build integrated equipment for a field function which has so volatile a history as agricultural fertilizers. Fertilizer equipment must eventually be integrated with other types of field machinery in order to obtain the greatest savings in labor and materials. The modern trends in farm machinery development make this more necessary than ever before. Obsolete types of fertilizer applicators should be abandoned. The old split-type boot, for example, while doing fairly well at slow travel rates is often found to be unsatisfactory with modern tractor field speeds. This does not necessarily mean that speed of travel is to be a governing condition. Speed is justified only so long as the net result is an improvement. However, sound economics together with modern farm management calls for equipment that is balanced so far as possible with modern mobile power plants. The implement industry is doing something about this, and improved applicators are available. Since fertilizer materials are corrosive, it is essential to properly maintain even our most modern equipment to obtain dependable performance.

Another problem requiring attention is the development of better field units for operation in crop residues left on the surface. This is needed for both solid plantings and row crop operations. While deep tillage has appeal to many farmers, this practice is now used principally for corrective tillage work. Its effect is temporary, unless root growth is encouraged to penetrate the deeply tilled areas. Subsoil or deep placement of fertilizers, while showing some promise with the use of phosphates, requires much additional research study over a wide range of conditions before general practices can be established. It would appear that deep placement can be readily accomplished by the use of heavy draft mechanical equipment now available, if research and field experiments justify the added costs involved.

Air-Borne Equipment

The use of air-borne equipment has a great potential if the problems of drift can be controlled. Grasslands, particularly, offer opportunities for the use of the airplane. Already they are used extensively for rice fertilization and to some extent for range fertilization. A recent promising use of the airplane for fertilizer application comes from Hawaii(6), where spot fertilization for sugar cane has been accomplished successfully. The placement pattern is governed by the appearance of the crop as observed from the plane. This is a method of application that cannot be accomplished by fertilizer charged irrigation water, and if surface methods are employed, the expense of application is too great to be practical. This form of application may have merit for crops other than for dense vegetative crops like sugar cane.

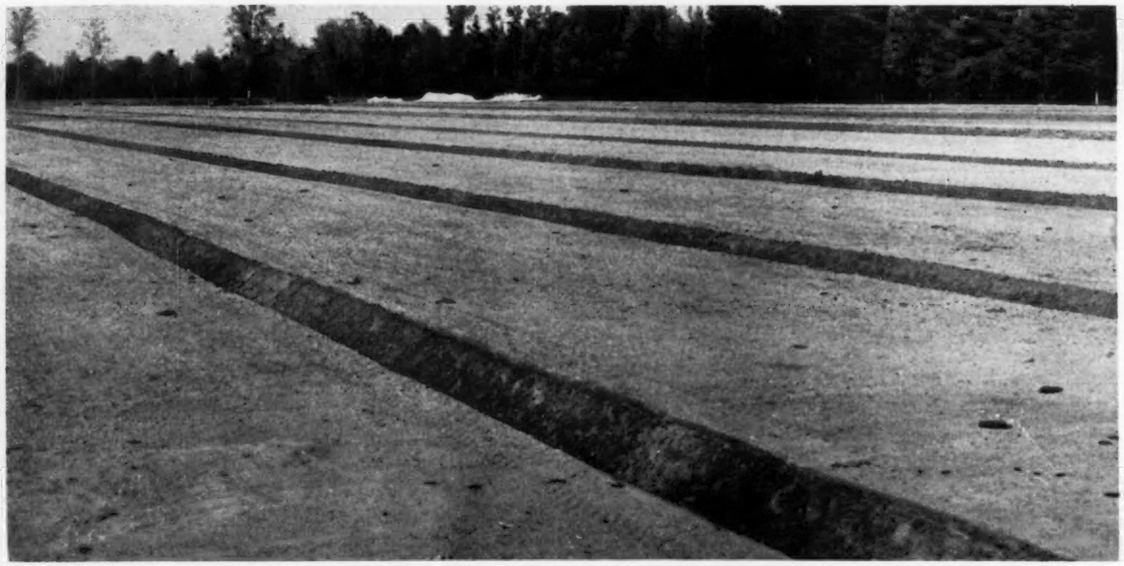
A British firm(7) has developed recently a "flying jeep for agriculture", which will carry a short-ton load of fertilizer and still be able to take off under full load in 115 yd and climb at a rate of 900 ft per min. Its maximum continuous speed is 140 mph, and its economical cruising speed is 118 mph. It is reported to stall gently at 33 mph. The development of planes of this type should accelerate the use of air-borne equipment for fertilizer placement.

Conclusions

Equipment for the spreading of manure, lime and gypsum appears to be fairly well standardized. These materials are applied at relatively high rates, so the metering problems are not as critical as for the high analysis packaged fertilizers. The problems of spray applications to plant foliage requires some attention. In most cases such applications are satisfactorily accomplished with standard spray equipment used for pest control, however, there are metering and corrosion problems with those for other liquid fertilizers. This type of application is used to some extent for fruits and vegetables.

(Continued on page 676)

660 AGRICULTURAL ENGINEERING • SEPTEMBER • 1957



Infiltration Patterns for Surface Irrigation

A few easy-to-take field measurements provide the necessary data for a new method of determining water absorption patterns for border or furrow irrigation systems

Herman Bouwer
Assoc. Member ASAE

WITH more and more emphasis being placed on the efficiency of water use for irrigation, the evaluation of surface irrigation systems (2)* becomes increasingly important. Evaluation of border or furrow irrigation systems partly serves to determine the size of water stream for adequacy and maximum efficiency of irrigation at the desired depth of water application. Of critical importance in this evaluation is the determination of the depth of water absorbed under different periods of inundation as governed by the change of the infiltration rate with time.

Some methods used in this connection are:

- Sampling the soil for moisture content before and after irrigation. This is a direct approach that should give an accurate measure of local infiltrations. However, sampling depths may be great, and deep seepage losses may be difficult to determine where there is a natural tendency for the soil moisture content to increase with depth.
- Measuring the infiltration behavior with ring-infiltrometers. Disadvantages of this method are that a number of measurements are required to characterize large areas (1), and that a certain caution must be exercised in the application of the results (3).
- Dividing the border or furrow into a number of sections and measuring inflow and outflow for each section. In case of mild slopes, however, the flow-measuring devices separating the sections may back up the water to the extent that they interfere with the normal course of irrigation.
- Adding tracer-elements to the irrigation water to a known concentration, and determining the accumulation of this tracer in the soil as a measure of the amount of water absorbed (4).
- Assuming a certain relationship between infiltration rate and time. Unless the assumptions are based on sufficient data from similar soils under similar conditions, serious errors may result.

This paper presents a method whereby the overall pattern of the time rate of change of the infiltration rate is determined from a limited number of field measurements that are relatively easy to obtain and are normally included in suggested procedures for evaluating surface irrigation systems (2). The method essentially consists of obtaining and processing a number of indirect observations of depth of water infiltrated during each of a series of time increments.

*Numbers in parentheses refer to the appended references.

The author — HERMAN BOUWER — is associate agricultural engineer, Alabama Polytechnic Institute, Auburn.

Nomenclature

D	=length of border in ft
W	=width of border in ft
V_t	=total water volume in cu ft delivered at upper end of border
V_L	=total water volume in cu ft lost at lower end of border
V_n	=net water volume in cu ft absorbed by border
$d_1=d_2=\ldots$	$=d_L=$length in ft of the several sections into which the border is divided, $d_1+\ldots d_L=D$ and $D/d=$number of sections per border
$v_1\ldots v_L$	=water volume in cu ft absorbed per border section, for each border $v_1+\ldots+v_L=V_n$
$T_1\ldots T_L$	=average inundation time in hr for each section
$t_1\ldots t_m$	=increments of inundation time in hr
$i_1\ldots i_m$	=infiltration in ft of water during corresponding $t_1\ldots t_m$
conj i_1 . conj i_m	=calculated i — values in feet†
$I_1\ldots I_m$	=average calculated infiltration rate in ft per hr during corresponding $t_1\ldots t_m$ ($I=$conj i/t)
$a_1\ldots a_m$	=fraction of corresponding $t_1\ldots t_m$ during which the section under consideration was actually inundated, $0\leqq a\leqq 1$, and Σ at$=T$ for any given T
h_n	=average depth in ft of water application per border, $h_n=V_n/DW$
h_a	=average depth in ft of water application per border as determined from the calculated conj $i_1\ldots$ conj i_m—values

Procedure

The procedure presented here is for border irrigation systems. The same principles, however, can be applied in the evaluation of furrow irrigation systems.

Field data required are: *(a)* The net volume of water V_n applied per border as determined by V_t and V_L. *(b)* Time measurements at certain intervals along the border to construct water advance and recession curves.

The measurements must be extended over a number of borders, using different water supply rates.

From the advance and recession curve, a time of inundation curve is constructed for each border. To minimize errors in the time measurements because of the generally irregular shape of the water front as it advances or recedes, irregularities in the curves should be smoothed. The borders are divided into a number of sections of length d, and the average time of inundation T for each section is measured from the time of inundation curve.

The selection of the time increments t is more or less arbitrary. To some extent this selection will depend on the magnitude of T. Since the analysis of the resulting equations becomes rather laborious if more than three increments are involved, t will generally be selected as about one-third of the largest T-values appearing in the trials. Inasmuch as the rate of change of the infiltration rate tends to be largest during the earlier parts of the inundation, it may be of advantage to select the first time increments smaller than the later ones. For the same reason, the first time increment should not be much greater than the smallest T-values of the trials.

The volume of water v absorbed per border section can be written as:

$$v=(a_1\,i_1+a_2\,i_2+\ldots+a_m\,i_m)\;d\,W \quad . \quad . \quad . \quad [1]$$

where v and a refer to the section under consideration. Summing over the entire border gives

$$\Sigma\ v=V_n=[(\Sigma a_1)i_1+(\Sigma a_2)i_2+\ldots + (\Sigma a_m)i_m]dW \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad [2]$$

Since $h_n=V_n/DW$, equation [2] can be written as

$$(\Sigma a_1)i_1+(\Sigma a_2)i_2+\ldots+(\Sigma a_m)i_m=(D/d)h_n \quad . \quad [3]$$

Similarly, equations can be developed for the other borders in the study. Because of the different water supply rates, different values for h_n and sums of $i_1\ldots i_m$ will appear in the equations.

The problem now is to solve a certain number n equations of the type of equation [3] with m unknowns, where n represents the number of borders in the study and m the number of time increments selected. For a solution of the equations, n must at least be equal to m. However, since certain inaccuracies may be expected in the equations (see discussion), it should be preferred to have $n>m$ so that the best fitting solution may be reached and a measure of the precision or fit of the solution may be obtained. Methods for the solution of indirect observations have been developed by Legendre and Gauss and are presented by van Uven (6). The resulting solution should be designated as conj i_1, conj i_2 . . . conj i_m.

Substitution of conj $i_1\ldots$ conj i_m into the equations [3] will give h_a-values that will generally differ from the h_n-values. To determine for a particular border the depth of water absorbed by each section, the i-values to be used in this computation are obtained by multiplying the conj i-values by the correction factor h_n/h_a belonging to the border in question. This will bring the depths of water application as calculated from T and the corrected conj i values in agreement with h_n as determined from field measurements.

Example

A border irrigation project at the Upper Coastal Plain Substation of the Alabama Agricultural Experiment Station, was evaluated to determine the rate of water supply for adequacy and maximum efficiency of irrigation at a desired application of 2 in or 0.17 ft. Field measurements were taken on six borders, using supply rates of 13, 20 and 39 gpm per ft of border width in duplicate. The former resulted in inundation times in excess of 3 hr, whereas the latter gave T-values of about 0.5 hr. On this basis, the time increments t_1, t_2, and t_3 are selected as 0.5 hr, 1.0 hr, and 2.0 hr, respectively.

An example of the calculation of equation [3] is presented in Table 1. The equations for the other borders are

†In order to simplify printing, conj i is used instead of $\bar{i}$ as it appeared in the original text.

. . . Infiltration Patterns

determined similarly, yielding the following set of equations for solution:

$$
\begin{array}{ccl}
\text{Supply rate in gpm per ft} & \text{border} & \\
13 & 1 & 10.00i_1+8.39i_2+4.45i_3=3.58 \\
13 & 2 & 9.30i_1+6.97i_2+2.40i_3=3.20 \\
20 & 3 & 10.00i_1+7.19i_2+0.42i_3=2.88 \\
20 & 4 & 10.00i_1+4.22i_2 \qquad =1.84 \\
39 & 5 & 8.86i_1+0.12i_2 \qquad =1.69 \\
39 & 6 & 8.16i_1+0.18i_2 \qquad =1.79
\end{array}
\quad . \quad [4]
$$

Solution of these equations according to Legendre and Gauss gives the following results:

$$\text{conj } i_1=0.190\pm0.03$$
$$\text{conj } i_2=0.094\pm0.07$$
$$\text{conj } i_3=0.232\pm0.12$$

These values can be expressed in terms of infiltration rates in ft per hr (symbol I) per time increment as:

during t_1 (0—0.5 hr) $\quad I_1=0.380\pm0.06$
during t_2 (0.5—1.5 hr) $\quad I_2=0.094\pm0.07$
during t_3 (1.5—3.5 hr) $\quad I_3=0.116\pm0.06$

The results indicate an average infiltration rate of about 0.4 ft per hr during the first one-half hour of inundation, and a basic infiltration rate of about 0.1 ft per hr for the rest of the inundation period.

Substitution of the conj i-values into the equations [4] gives the following values for h_a and h_n/h_a:

border	h_a	h_n	h_n/h_a
1	0.372	0.358	0.96
2	0.298	0.320	1.07
3	0.267	0.288	1.08
4	0.230	0.184	0.80
5	0.169	0.169	1.00
6	0.157	0.179	1.14

TABLE 1. EXAMPLE OF CALCULATION OF EQUATION [3]

Border No. 1	Water Supply rate: 13 gpm per ft	
D = 1000 ft	V_t = 22000 cu ft	h_n = 0.358 ft.
W = 60 ft	V_L = 500 cu ft	t_1 = 0.5 hr.
d = 100 ft	V_n = 21500 cu ft	t_2 = 1.0 hr.
		t_3 = 2.0 hr.

section in feet from head of border	T in hours	a_1	a_2	a_3
0-100	3.47	1	1	0.99
100-200	3.33	1	1	0.91
200-300	3.13	1	1	0.82
300-400	2.88	1	1	0.69
400-500	2.57	1	1	0.53
500-600	2.22	1	1	0.36
600-700	1.80	1	1	0.15
700-800	1.37	1	0.87	—
800-900	0.95	1	0.45	—
900-1000	0.57	1	0.07	—
		$\Sigma a_1=10.00$	$\Sigma a_2=8.39$	$\Sigma a_3=4.45$

equation: $10.00\, i_1+8.39\, i_2+4.45\, i_3=3.58$

A fairly good agreement appears to exist between h_a and h_n, except for borders 4 and 6. These discrepancies and the relatively small number of observations for a least-squares solution are probably the main reasons for the large errors in conj i.

Using the corrected conj i-values and the section inundation periods T, the depth of water application per section can be computed, and since the desired application and V_t are known, the adequacy and efficiency of irrigation can be determined for each border.

Discussion

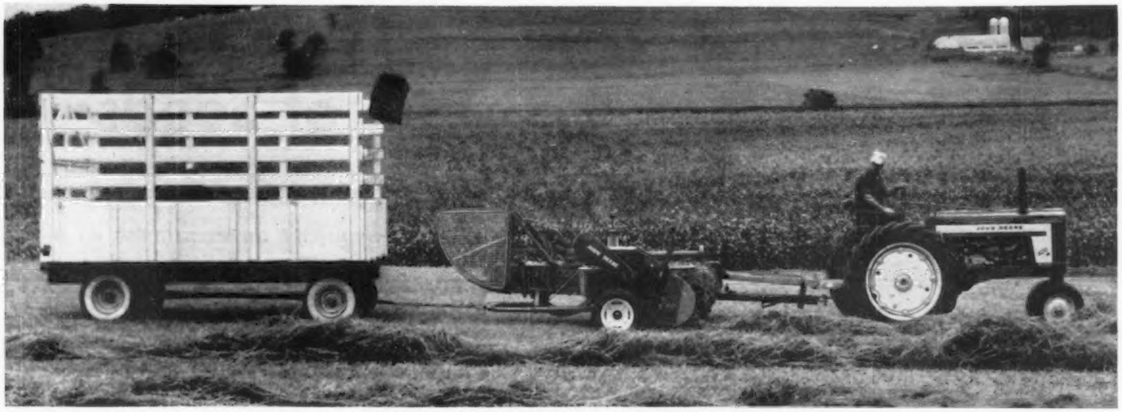
The i-values appearing in equation [3] are averages for the corresponding time increments t. Where fractions of time increments are involved ($0 < a < 1$), i has been considered to be constant for the stated time increment. Consequently, an error is introduced in the derivation of equation [3] and the use of conj i in depth of water absorption computations where fractions of time increments are involved, particularly where there is a rapid change of the infiltration rate with time, or a variation in a from 0 to 1 for a certain border and time increment (for instance the a_3-values in Table 1). Since the largest infiltration rates occur during the beginning of the inundation and since t_1 is generally selected on the basis of the smallest T-values of the study (a_1 equal to or close to 1 for each border section), this error will tend to exert a minor influence on the results. If desired, some refinement may be obtained by evaluating and using instantaneous infiltration rates in the calculation of the depth of water absorbed by each section under fractions of time of inundation increments. A curve showing approximate instantaneous infiltration rates as a function of time can be obtained by properly constructing a smooth curve through the tops of the bars of a bar graph showing $I_1 \ldots I_m$ as ordinates for the corresponding time increments as abscissa.

Since the evaluation of conj $i_1 \ldots$ conj i_m is based on data from a number of borders or furrows, a reasonable degree of soil and surface uniformity should exist over the area under study. Assuming that the time and discharge measurements are relatively free of error, non-uniformities will be reflected in the error of conj $i_1 \ldots$ conj i_m and in the h_n/h_a-ratios.

The different sizes of water stream employed in the studies will produce different flow depths of the water in the borders or furrows. Although some positive effects of the depth of inundation on the infiltration rates have been reported (5), theoretically there can be no appreciable effect from surface heads in the case of border irrigation where the flow depths are in the order of 5 in. and the variations perhaps 1 or 2 in., except for the first parts of the inundation when depth of water penetration is still small. The method presented in this paper, however, may serve as a tool to evaluate this and possibly other influences by introducing certain correction factors and by studying the effects of these factors on the mean errors and the h_n/h_a-ratios.

In evaluating furrow irrigation systems, at least three adjacent furrows should be irrigated with the same stream size, and the field measurements be limited to the center furrow or furrows to avoid border effects. In processing the data, W is taken as equal to or a multiple of the row distance, depending on the number of furrows treated as one observation. If the effect of stream width on infiltration can

(Continued on page 676)



Takes the "Crew" Out of Haying

THE new John Deere hay baling system, which reduces the processes of baling and storing of hay to one-man operations, may be as successful in eliminating the "haying crew" as the combine has been toward elimination of the "threshing crew" during the past few years. This comparison is based on the following report from the manufacturer.

The new system consists of a new bale ejector attachment for the company's twine-tie balers that loads wagons automatically, and includes a new elevator and barn conveyor equipment that stores bales automatically. In operation the twine-tie baler, equipped with a bale ejector, makes bales approximately half size. Bales are ejected through the air directly into wagons with high sides. Only the man driving the tractor is required.

Bales are then delivered to the elevator at the barn, dumped into the new 8-ft, general-purpose hopper, and delivered to a bale conveyor hung from the ridge pole in the barn. The conveyor receives bales from the elevator and distributes them through the full length of the barn. Provision is made for discharging bales from the conveyor to either side at 10-ft intervals. No stacking is required with short bales. It is reported that storage space is reduced approximately 10 percent, depending on the weight of the bales. At the same time, better air circulation is said to reduce fire hazards.

In the labor saving department the introduction of the new bale ejector goes beyond the labor savings effected by the automatic baler. While the automatic baler eliminated two and, in some cases, three men's help over the old manual-tie windrow-pickup baler, the new bale ejector makes the job completely automatic by eliminating bale pickup men or men on the wagons behind the baler. At the barn, the man hauling the bales in the wagon simply dumps the easy-to-handle short bales into the elevator hopper, sending them to storage. No other help is required. In most cases, at least two men formerly required to stack bales in the barn are eliminated. Short bales have the added advantage of easier handling at feeding time. Back-breaking labor is reduced when carrying the lighter bales to the livestock.

New equipment for the John Deere portable elevator includes the large, bale-size, general-purpose hopper, which also handles small grains, ear corn, and ensilage besides baled hay. The hopper is spring-loaded and is raised and lowered for quick "spotting" of loads. A short-bale guide attachment keeps short bales elevating at much steeper angles. The bale conveyor for the barn is available in sections to match any barn length. It is powered by an electric motor or gasoline engine.

(For more facts circle No. 41 on reply card)

(Left) At the barn, one man can dump the short bales into the elevator hopper. *(Right)* Conveyor, attached to ridge pole of barn, can be arranged so that bales are discharged from the conveyor to either side at 10-ft intervals

Methods and Equipment for
Low Energy Irradiation of Seeds

O. A. Brown,
R. B. Stone, Jr., and
Member ASAE
Henry Andrews

Low cost equipment requiring only a fundamental knowledge of electricity shows promise as aid to research in the application of irradiation of seeds

SINCE the invention of electric generators man has endeavored to discover the effects of electric energy on living organisms. The advent of each major discovery in the field of electricity has immediately been followed by intensive effort to apply the new knowledge to the science of biology and to induce physical changes in the characteristics of plants.

According to Riccioni (4)* the idea of irradiating seeds with electric energy for the purpose of inducing changes probably first was used by Nollet in the year 1747. The electric energy was produced by a friction machine.

There are many ways to apply electric energy to living organisms. The simplest is to make the organism a part of an electric circuit and pass the current directly through it by applying a potential. Either d-c or a-c potentials may be used. For this kind of experiment measurements are rather simple but results cannot be predicted because of the variable parameters of materials. Fig.1 is an oscillogram of an electric current through a grain of corn held between carbon electrodes. I_x is the current through a grain of corn and I_1 is the current through a parallel fixed resistance. The polarity was reversed at one-minute intervals. Many experiments similar to this have been performed. Potentials have been applied to grains of corn which have been in water for various lengths of time. Many different kinds of electrodes have been used and corn from dry (approximately 10 percent) to wet (approximately 30 percent) has been used as a part of a circuit between the electrodes with different pressures applied.

If the corn is dry a high potential (near 1000 volts) is required to produce a measurable current and it often happens that an electric arc causes burning at the surface due to point concentration of currents. If the corn is wet, ions are transported and an electric potential builds up between the surface of the corn and the electrodes. A grain of corn has no fixed potential but may produce a rather large potential (as much as 1½ volts has been measured) between electrodes. All seeds are not alike in this respect, and single cross hybrid and open pollenated corns which have been the subject of much of our research show wide variations among seeds that appear to be alike in other respects.

Paper presented at the annual meeting of the American Society of Agricultural Engineers at Roanoke, Va., 1956, on a program arranged by the Rural Electric Division.

The authors — O. A. Brown, R. B. Stone, Jr., and H. Andrews — are, respectively, formerly senior agricultural engineer, associate agricultural engineer, ARS, AERD, Division of Farm Electrification and assistant in agronomy, Tennessee Agricultural Experiment Station, in cooperation with USDA.

*Numbers in parentheses refer to appended references.

Radio Frequency

Another method which has been used to apply energy to seeds is to place the seeds in an electric field of radio frequency. This method has been used by a number of experimenters and has been presented in a paper by Jonas (1). Such treatment subjects the seeds to a strong electric field but the magnetic field is weak.

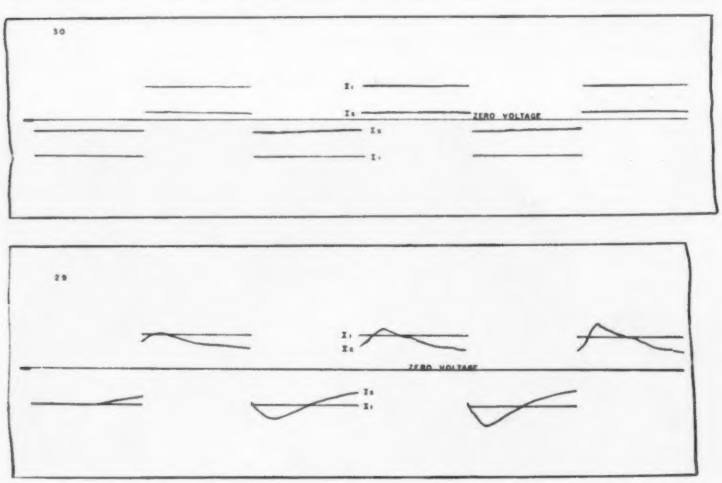


Fig. 1 Oscillogram of an electric current shows passage through a grain of corn held between carbon electrodes. I_x is the current through the corn and I_1 is the current through a parallel fixed resistance. (Note: Voltage above zero line, anterior side of seed is positive. Voltage below zero line anterior side of seed is negative. Response of galvenometer I_x and I_1=same scale. I_1=60 volts per 16,500 ohms, I_x=60 volts per seed impedance. Each reversal=1 min.)

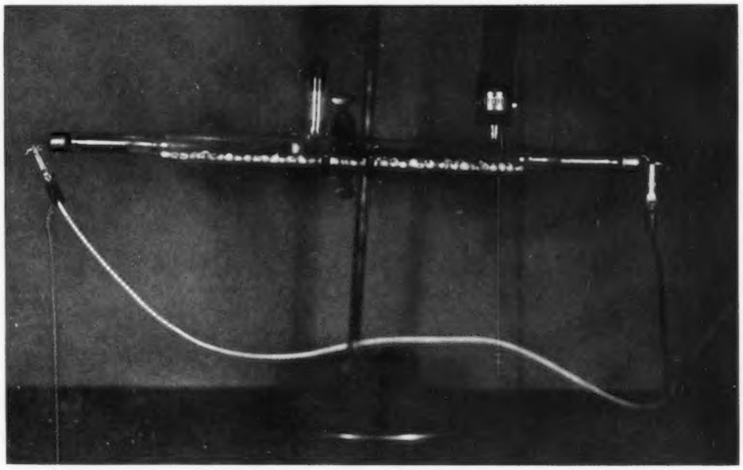


Fig. 2 A container used satisfactorily is made of a 14-in. section of 1-in. diameter glass tubing with neon-sign electrodes attached to each end

A somewhat different treatment is obtained by placing seeds in an electric field and increasing the potential until an electric arc forms between electrodes. This method of treating seeds was used by Riccioni (4). The electric discharge method subjects the seeds to both high electric and magnetic fields but at different times. Field seeds may be subjected to this kind of electromagnetic radiation when a lightning discharge between a cloud and the earth strikes in a field.

Several experimenters have reported effects of various electromagnetic treatments on seeds. The objective of most of the experimenters has been to establish some relation between electric energy and living organisms. A few have tried to use low energy radiation to produce mutations and develop new varieties with greater yielding ability. Because of the wide variation in biological materials, and in radiated electromagnetic energy, it is not surprising to find conflicting reports in the literature on the subject dealing with effects of electromagnetic radiation. It is often quite difficult to check results of the electric effects on seeds even under the most carefully controlled conditions. The fact that changes are induced in seeds by electromagnetic radiation of low energy level is easily demonstrated. It is also easy to demonstrate that seeds produce electric potentials (3). The reasons for radiation effects or for the variation in electric potentials generated by seeds is not easy to explain.

Radiation Opportunities

There is a broad range of opportunities for investigators in the field of low energy radiation because of the almost astronomical number of combinations of materials, moisture contents of materials, intensity of energy applied, frequency of the energy source, and methods of application of the energy to the materials to be studied. Many scientists have conducted research in the application of radio-frequency energy to biological materials of all types, and doubtless many more would be interested in doing research along these lines but are deterred by the high cost of equipment and/or the lack of experience in high frequency techniques. It will be of particular interest to this latter group of scientists to learn that while most of the research in irradiation of seeds has been done with relatively high frequency power sources, there remains a field, still unexplored, which may be reached with low frequency.

New Application Method

This paper will describe equipment and techniques which require a moderate outlay of capital to obtain and only a sound fundamental knowledge of electrical theory to use. The method of applying electric energy to biological material is adaptable to high as well as the low frequency sources and is offered as a tool which, it is hoped, may be used to advantage in the field of research.

The principal difference between this method of applying electric energy to biological materials, and the methods commonly used is that the material is treated at pressures less than atmospheric and is subjected to radiations produced by a glow discharge. The method has the advantages of being under the control of the experimenter. Both the electric and magnetic fields can be controlled. The experiments can be repeated with confidence and the results obtained can be compared.

Procedure and Applications

The apparatus consists of a tube fitted with electrodes at each end, a vacuum pump equipped for pressure regulation, and a variable high voltage source.

Seeds are placed in the tube in the space between the electrodes, and the tube is evacuated to some predetermined pressure at approximately 1.0 mm of mercury (Hg). An electric potential is applied between the electrodes, and current is produced in the circuit. At low potentials the current is the result of the movements of free charged particles. As the potential is increased a point is reached where the velocity of the free electrons is great enough to excite the gas molecules with which they collide causing these molecules to radiate light energy. The current increase at the excitation potential is due to photoelectrons liberated by light from the excited molecules. A greater increase in potential increases the velocity of the electrons sufficiently to ionize molecules with which they have collisions (2) (5). When ionization occurs the inner volume of the partially evacuated tube is almost entirely filled with a luminous region known as the plasma.

Under some conditions the plasma is not continuously luminous but consists of a succession of light and dark re-

. . . Low Energy Irradiation

gions in a regular order. These are known as striations and the potential gradient varies with the bright and dark regions. However, the potential gradient of the unstriated column is uniform.

The amount of current can be regulated by adjusting the potential, and seeds placed in the tube can be exposed to the radiation which is produced by a relatively constant electric potential and current of any value desired within the limits of the equipment. The gas pressure in the tube can be regulated over a wide range. Since the voltage necessary to produce an electric discharge through the tube is a function of the pressure of the gas in the tube, the breakdown voltage for cold-cathode discharges can be controlled by changing the gas pressure.

The operator has no control of the gases liberated in the tube by the material being treated.

Glow discharges in gases at low pressures may be produced with little difficulty from direct current throughout the radio-frequency spectrum. Ultrahigh frequencies produce plasmas of high ion and electron densities and good uniformity of distribution. At the ultrahigh frequencies it is necessary to use wave guides and to practice proper microwave techniques.

As a research tool the apparatus has many potentialities. Materials may be placed in the discharge tube where they are subjected to all the radiation and the bombardment of ions and electrons and to the pulsation frequencies inherent to glow discharge. The discharge tube may be surrounded by a second tube in which the material is placed. The inner tube may be made to shield the materials from light radiation and from bombardment by ions and electrons or it may be made to pass certain radiations and shield the material from ion and electron bombardment. Radiation of the glow discharge may be varied by using different gases in the tube.

Equipment

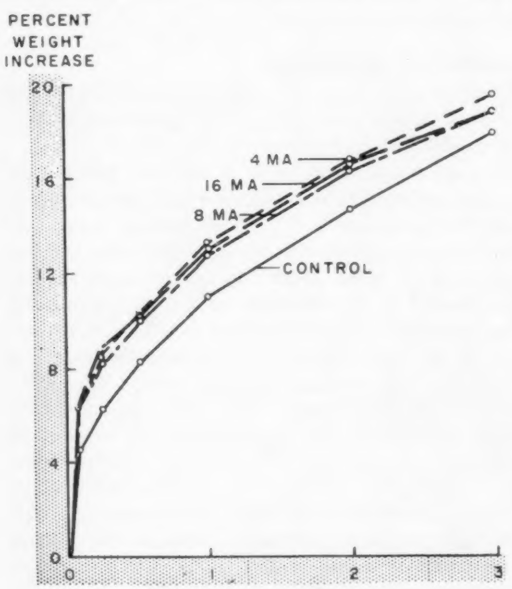
The following list of equipment is adequate for a wide variety of experiments:

- 300-watt variable voltage transformer
- 7500 V, 70 ma (milliampere) neon sign transformer
- Vacuum pump
- Instruments (milliammeter, peak voltmeter and vacuum gauge)
- Container for material to be treated

Fig. 2 shows a simple setup of the equipment.

The choice of containers in which the material is to be irradiated is flexible. Any material of sufficient density to hold gas under the desired pressure may be used. However, materials which are electric conductors present a major problem as to spacing and insulation of the electrodes. At the present stage of the investigations, contamination of the gases by the container material has not been found to be a limiting factor, but it may be anticipated that subsequent findings may eliminate the use of some materials. The above remarks deal with containers in which the gases are excited by comparatively low frequency sources, and in which the material will be subjected to all of the radiations generated by the excitation of the gas molecules, and the bombardment by ions and electrons.

On this project, containers principally used are of insulating material, *i.e.,* glass, synthane, fused quartz, polystyrene, etc., and are of standard shapes, usually tubing. The type shown in Fig. 2 has proved to be particularly adaptable to the work. This container is made of a 14-in section of 1-in diameter glass tubing with neon-sign electrodes attached to each end.



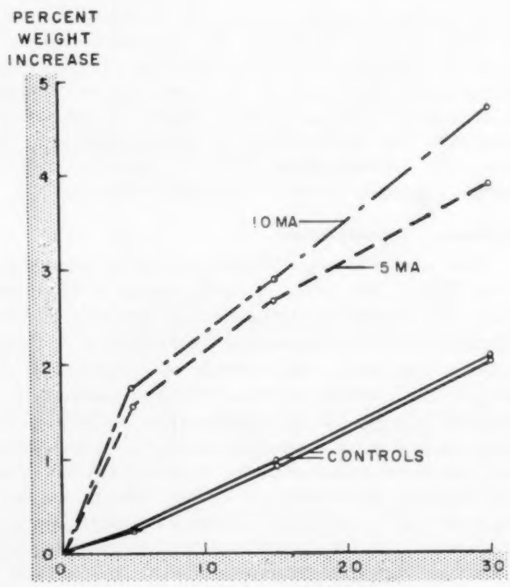


Fig. 3 *(Left)* Shows rates of water sorption of corn after irradiation with 4, 8 and 16 ma, 60 cycles • Fig. 4 *(Right)* Shows rates of water sorption of soybeans after irradiation with 5, and 10 ma, 60 cycles

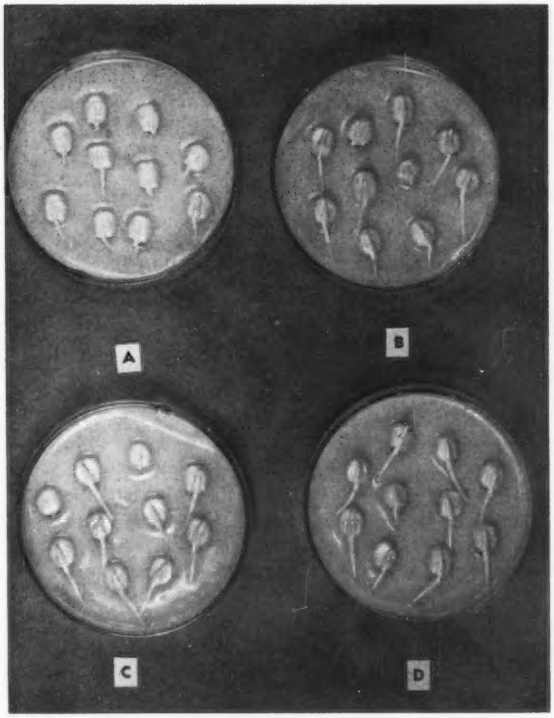


Fig. 5 Experiments in corn show slight stimulating effect on germination in free water. A is control, B, C and D are seeds irradiated at 5, 10 and 15 ma, respectively

Results

The effects of radiation on some seeds are quite pronounced. Three effects which are easily observed in seeds exposed in an electric discharge tube are:

(a) The rate of water sorption of seeds exposed to electromagnetic radiation is increased.

(b) Corn exposed to a limited amount of radiation germinates quicker and more uniformly in a petri dish of free water than does untreated corn.

(c) If the radiation is made sufficiently intense the seeds are killed.

All of these effects may have economic values. Since the seeds are made more permeable to water, it is possible that seeds irradiated in an electromagnetic discharge would be more easily dried than seeds not so treated. The heat of the evaporation could be furnished by the electric energy and low pressure promotes evaporation.

Fifty seed samples of T18 x T14 white field corn were irradiated with 4, 8 and 16 ma, 60 cycles for five min. Water sorption rates of these seeds and of a control were determined. The results are given in Fig. 3. As in all the experiments the rate of water sorption of the irradiated seeds was significantly greater than the rate of water sorption of the control. However, the intensity of the irradiation within the limits used appears to have no effect on the rate of water sorption by the seeds.

Further investigation of the effect of irradiation on seed water sorption rates of Ogden soybeans was made. Two lots were irradiated at 5 and 10 ma, 60 cycles, respectively, and the rate of water sorption checked against that of two lots of untreated soybeans. The results presented in Fig. 4 show the percent weight increase for soybeans.

The effect of irradiation on the water sorption rates of soybeans is more pronounced than that noted in the experiments with corn. Within a few minutes after being placed in water the size of the irradiated seed was approximately double that of the control seed, and after thirty minutes the irradiated seed disintegrated.

Conclusions

These results open up a new field of investigation into the possibility of using irradiation to shorten the cooking time required for dehydrated seeds used as food. Another aspect of the effect of irradiation on water sorption of seeds is the possible use of this method to increase the rate of germination of hard seeds. Some experiments have been conducted along these lines.

Experiments have been performed with seeds to determine the effect of the radiation on germination, growth and productivity. Numerous experiments with corn show that there is a slight stimulating effect on germination in free water (Fig. 5). The corn seeds exposed to radiation for a short time will germinate somewhat quicker and more uniformly than unexposed seeds.

There have been field trials with corn covering a two-year period. In both trials corn grown from irradiated seeds has not shown a significantly higher yield than the controls.

A quantity of irradiation which may stimulate germination in one seed may inhibit it in another. A mixture of seeds may be irradiated with an energy level which will kill the embryo of one species and at the same time not inhibit germination of the other. Only a few species have been used in the experiments and it has not been determined if certain seeds which infest field crops can be killed by radiation. However, a mixture of red clover with purple-top turnip and smooth mustard with purple-top turnip showed that the germination of the turnip seeds could be completely inhibited without apparent injury to the clover or mustard seeds. In this experiment the seeds were grown under field conditions.

References

1 Jonas, Herbert. Some effects of radio frequency irradiations on small oilbearing seeds, Physiologia Plantarum, Vol. 5, pp. 41-51, 1952.

2 Loeb, Leonard B. Basic processes of gaseous electronics, University of California Press, Berkeley, Calif., 1955.

3 Nelson, Oliver E. and Burr, H. S. Growth correlates of electromotive forces in maize seeds, Proceedings of the National Academy of Science, Vol. 32, No. 4, pp. 73-84, April, 1946.

4 Riccioni, Dott. Bindo Il trattamento elettrico del semedi grano, Istitute Italiano D'Arti Grafiche, Bergamo Milano Roma, 1942.

5 Thompson, J. J. and G. P. Conduction of electricity through gases, vol. II, third edition, Cambridge at the University Press, 1933.

Tomorrow's Agricultural Engineers — Their Training

F. J. Hassler
Member ASAE

SINCE the opportunities and responsibilities in the field of agricultural engineering have been presented by Harold E. Pinches in an article "Tomorrow's Agricultural Engineers — Their Opportunities" (7)*, this article deals with the formal professional education, which is important for the obvious reason that, in the main, the graduates from agricultural engineering departments fill the ranks of ASAE membership.

First, professional endeavors must be defined so as to permit an objective interpretation of educational requirements. This definition must also convey the justification for the agricultural engineering curriculum in the learning process. This latter consideration is becoming of greater importance because the concern for the standards of education and the demands for economies in formal instruction bring all programs under careful scrutiny. While it can be argued that it is the specialization in formal study that captivates the interest of a certain percentage of students to carry on the responsible work of the agricultural engineering profession, the tendency is becoming stronger to emphasize, in teaching a specialty, those areas of thought that are considered basic to a well-educated man.

Although any definition is incomplete and hazards misinterpretations, the following is offered for the purposes of this presentation: "A profession is a responsible element of society that, by dedicating its total efforts and continuity of purpose to a recognized area of problems, offers reasonable solutions to these problems so as to assist in the maintenance of balance in man's striving for the advancement of civilization." This definition contains the requirements of discipline and responsibility, and implies the obvious—that professional prerogatives are ordained by society. To give further meaning to this definition in relation to education, Justice Brandeis' qualifications (2) for a profession follow: *(a)* "A profession is an occupation for which the necessary preliminary training is intellectual in character, involving knowledge and to some extent learning, as distingushed from mere skill," *(b)* "It is an occupation which is pursued largely for others and not merely for one's self," *(c)* "It is an occupation in which the amount of financial return is not the accepted measure of success".

These statements might seem at first too classical for present day thinking. However, experience confirms that they assert the conditions upon which any profession maintains its prerogatives and by which it receives honor and recognition from society; otherwise, independence disappears and professional members become controlled employees who obtain no greater satisfaction than the securing of an adequate income.

The recognized problem area for the agricultural engineering profession has been described as that of providing engineering service to agriculture. The uniqueness of this activity is assured and its importance is self-evident by the fact that agricultural engineers are serving society in the acquisition of its most basic needs—food, fiber and other raw materials for industry. Therefore, the only contingency is that agricultural engineers prove effective, and the challenge to both educational requirements and professional endeavors is, on the first order of consideration, whether they can think big enough to properly anticipate, confront and solve the problems that arise in a prosperous but advancing society. Indeed, a broad perspective is required to comprehend the scope and complexity of agriculture and the industries that serve it. Agricultural engineers' thinking should be broad enough to recognize the fact that there is need for other engineering specialties to practice within the scope of the profession without being suspicious that these activities constitute an encroachment. This is important for it is impractical to develop workers in the many special techniques for two substantial reasons: *(a)* This would constitute duplication in educational programs, and *(b)* to provide training in the many techniques would detract from other more meaningful endeavors so vital to over-all professional responsibilities. Mr. Pinches calls attention to this by his suggestion that agricultural engineers should supply the imagination and knowledge as to the possibilities in the application of power, energy and materials to new methods of farm operations and processes (the training for this responsibility is most consistent with the program of land-grant colleges and universities); mechanical engineers or others trained in particular methods should logically take care of specific designs. In addition, a more realistic and honest interpretation of the scope of our existing and potential endeavors would cultivate a professional attitude more conducive to soliciting the advice of the other disciplines in agricultural science. Such outward thinking would also promote a more tolerant attitude among the members of the agricultural engineering profession, which engages workers in activities ranging from vocational skills through teaching, research and development, to unrealized ideals as an open end.

Educational Requirements

Let us turn now to an examination of the educational requirements for our specialty. The diversity of professional endeavors recommends that, in a practical sense, there is

Paper presented at the Southeast Section of American Society of Agricultural Engineers, Birmingham, Ala., February 5, 1957.

The author — F. J. Hassler — is professor in charge of graduate studies, agricultural engineering dept., North Carolina State College, Raleigh.

Acknowledgment: The author wishes to express his appreciation for the contributions to the paper from his associates as well as the extensive literature on this subject. Most of the ideas have evolved from departmental discussions of educational processes and some of the proposals have been tested in undergraduate and graduate programs conducted at North Carolina State College.

*Numbers in parentheses refer to the appended references.

need for two programs of study if students are to be attracted in sufficient numbers to cope with our responsibilities in service to agriculture. While both programs must conform to the general aims of higher education, the two types of specialization would give students of different ambitions a choice in the manner they will serve. Both programs of study by commencement time should have the student know himself, his limitations and he should possess the will to continue his intellectual growth, for self-education must take over somewhere in the life of every successful student. One program would be designed to afford training adequate in the ways and means of applying existing developments to problems under given circumstances—a type of preparation for the expected or foreseen situations. The second course of study would give the student greater opportunity for developing his creativeness as preparation for the unexpected and unforeseen situations. The former type of specialization can be obtained by mastery of techniques and a ready acquaintance with facts; the latter, however, requires a working appreciation of scientific knowledge and competence in abstract thinking. Taken together these two objectives encompass the scope of the agricultural engineering professional activity—one through direct contact with work-a-day society and the other in circumspection. Regardless of curricula, continuous effort must be directed to the elevation of educational standards for the greater development of the students' ability to reason! This is not only necessary if the profession's effectiveness is to be advanced, but is owed to the students so that they might have the comforting confidence of wisdom; it is well to recognize that the human mind is an instrument of far greater capacity than ever fully utilized.

Present Teaching Methods

If we examine our past performance in education we can readily identify that, while the instructional programs have proved successful for training workers in the application aspects of the profession, it has fallen far short of the educational requirements for developing the creative thinkers who will continually advance the perceptiveness of our endeavors. It is in respect to this deficiency that the remainder of this paper will be devoted so as to develop the argument of what is required if the full measure of a profession is to be realized.

There surely is nothing inherent in the makeup of the agricultural engineering curriculum that would prevent the turning out of the well-educated man. In fact imaginative teachers have found that engineering curricula offer unusual advantages for developing well-educated people because of the tangible examples available and the relationship of these examples to social and economic life (4). Experience in engineering education has verified the following subject areas as essential to all engineering professions: principles of communication, humanities, basic sciences, and engineering sciences (3). While there remain scattered arguments about the relative amounts of formal course work needed in these subjects, major disagreements are incurred when it comes to programming the type and amount of specialized instruction furnished by the degree-granting department. This has the obvious implication that, if the above subject areas are necessary, then only the degree-granting department has the opportunity to round out an effective program of study. What are agricultural engineers to do about this? Much has been said about course substitution and/or additions as a means to strengthen recognized weaknesses in agricultural engineering graduates. Some have suggested that it will take a fifth year to provide the student with all the necessary course work. Whatever the approach that has been taken, the results to date give one conclusion: curriculum "doctoring" per se has given if anything an illusion only that improvements are being made.

If the subject matter that is important to the learning process in engineering education has been agreed upon, it is logical that shortcomings lie with the inadequacies of teaching. It is quite natural, however, that teachers, generally speaking, will continue to hunt for physical remedies rather than question their own competences and methods. Courses are prescribed that have proper topical content, but sound judgment on the requirements of effective teaching for stimulating imaginative thinking on the part of the students is neglected. This should be a never-ending challenge. The following recommendations are suggested as means for improving the thinking ability of four-year students. These recommendations are based on the following postulated conditions: *(a)* that the basic studies (including a course in differential equations) and engineering sciences now common to the professional curriculum are necessary and essentially adequate, in respect to subject matter, as precision type learning for engineering education; *(b)* that the subject matter coverage given in agricultural engineering offers sufficient examples, for the present at least, of engineering applications relevant to professional endeavors; and *(c)* that there is greater opportunity to develop more effective professional workers through improvements in teaching methods than in curriculum changes among subject matter.

Creative Thinking

A first consideration must be that of providing students with sufficient time to assimilate learning. It has been observed that student time is the scarcest resource on college campuses. (Those in land-grant colleges might justly welcome the opportunity to compare this with the availability of faculty time for creative thinking. But for the present this question can be resolved by agreeing that insufficient time for both students and teachers militates against the learning process.) By the present methods the amount of effective learning in relation to the time students spend in the classroom is surely well past the point of diminishing return. But before anyone goes on a crusade to liberate students from too much time in the classroom, some assurance must be had that they will use additional free time to better advantage—that they have an attitude and desire for learning – otherwise proneness to procrastination will make free time less meaningful than classroom attendance.

The lack of student interest in a real learning experience might well be the greatest hindrance to education today; but imaginative teaching is the only cure for this illness. It must be realized that the impulse for self-development comes from within the student, but this impulse can be stimulated from the outside and likewise it can be killed. It is the great function of the teacher to kindle interest in his students. For the teachers of the basic subjects to stimulate young minds requires a genius that is all too rare because these studies involve the acquisition of know-

ledge that appears inert to freshmen and sophomores. Here is a real hazard since this is the students' only opportunity to lay the necessary foundations in communications, mathematics, physics and chemistry. Therefore, discouragement or indifference during these studies is tantamount to mediocrity or failure in the development of creative reasoning. To correct this condition offers real opportunity because most students of so-called average intelligence, who have a sincere interest in acquiring an education, will come out with adequate learning in all subjects. It is a challenge, therefore, to furnish means for avoiding this loss in potential talent.

Practical Approach Offered

The following is proposed as a practical approach: Rather than rely on the teaching talents of instructors in these basic studies for supplying the necessary stimulation with the means at their disposal, those in the professional department should initiate more effective counselling and seminars during the freshman and sophomore years for the express purpose of inspiring agricultural engineering students to greater intellectual development. These engagements with them will have real meaning for they will feel the confidence and sincerity of faculty members from the profession of their choice.

It is a responsibility to have them attending these basic courses with an attitude of expectation and looking for something, in the realm of learning, instead of quality points only. There is beauty in knowledge and to quote Whitehead (9) "Show youth where beauty dwells and there he will dwell also." During such seminars the importance of basic knowledge could be demonstrated by relating it to typical examples of professional interest as well as the generality of its application. The inert and precision knowledge of mathematical methods and physical concepts could be made active in their rational consciousness by this approach. Instruction in the philosophy and heritage of agricultural engineering would spur them on to greater interest in learning by giving them the feeling of purpose. This is also the time to stress the place for humanities in their curriculum by defining the agricultural engineering profession as an activity in the total social enterprise.

It cannot be expected, however, to obtain satisfactory results at bargain rates because proper counselling of this type requires a vigorous departmental faculty who can conduct itself in the broad reaches of knowledge and who obtain personal joy from watching the intellectual potential of young minds unfold.

Students that are successful during their first two years will find the engineering sciences enriching for the most part. Here the student will see for the first time the concepts and laws, that describe natural phenomena, formulated into principles for practical applications. However, the examples employed will generally be idealized as a means to elucidate the principles rather than to provide experience in methods of analysis. It is during this period that the student's imagination begins to extend and he starts taking on a type of curiosity that distinguishes him as an engineer. This sets the stage for agricultural engineering instruction, which is to round out his formal education. Will the graduate be a creative individual who will face professional endeavors with confidence or will he be lacking in the ability to utilize knowledge to the extent that he approaches problem situations on the basis of "common sense" or inventive skill? Remember, he has been required to absorb much mathematics and scientific knowledge of an inert type. Was this done only because everyone is saying that engineering of today is founded on science? Unless students are brought to an appreciation of their power in the utilization of this knowledge, they will have every right to question the place for such study in their curriculum.

Order and phenomena in nature have been described by laws and concepts which mathematics has formulated for man's effective and efficient use. Principles and causal relationships give power and breadth to the body of scientific knowledge. This is a product of the human intellect and therefore can be utilized only by rational thinking. This is the basis of all noticeable engineering today and for this reason the title of practicing engineers is being expanded to "engineering scientist." Therefore, a responsible profession *cannot* rely on the inventive or "common sense" type of approach to engineering problems in preference to logical use of scientific knowledge and methods. Agricultural engineering should be more demanding in its reliance on the fundamentals of science than other professions because of the complexity of its problems and of the dispersion of its activities. All forms of energy, forces and materials must be taken into account if alternatives are to be considered fully. Also, most of our activities must accommodate the sensitivity of biological systems. In comparison agricultural engineers work under circumstances that require greater self-reliance if they are to be productive; therefore, for him to maintain a conscious awareness of scientific knowledge he must rely on the few underlying generalizations rather than the many facts and causal relationships.

Objectives of Study

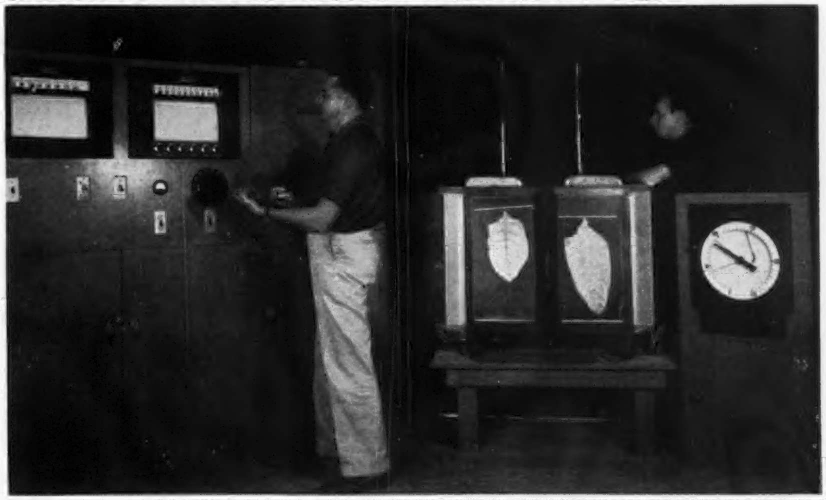
These interpretations point up three main objectives for instruction during the last two years of the agricultural engineering curriculum: *(a)* strengthen the students' understanding of science; *(b)* provide effective experience in analysis and synthesis of problem situations pertinent to professional endeavors; and *(c)* improve their understanding and use of communicative skills and the relations in human affairs through personal expressions and faculty criticism of written and oral ideas relevant to the profession. To maximize these objectives will require that our present course offerings be integrated to provide more time for detailed theoretical analysis of a few typical problems.

The student should be instructed to approach professional problems with the purpose of submitting these problems to underlying principles rather than by applying relationships just because they work, which characterizes too much of the present instruction that goes from assigned problems to "correct" answers.

Active Participation by Student

Methods of imaginative teaching and creative learning have been systematized for effective instruction in which the student is an active participant (8). A problem situation should be first simplified by abstractions so as to elucidate the appropriate principle on which to base the analysis.

Fig. 1 Graduate students performing tests to characterize the response of tobacco leaf to curing environments. The object of this study is to formulate basic principles that will disclose new approaches to the problems in harvesting and curing operations



This permits the translation of the engineering situation into mathematical language for precise expression of relationships among variables. (The complexity of some problems, however, would require so large a number of abstractions that the models obtained would no longer represent reality; these cases require, instead of oversimplification, the application of statistical methods to obtain a measure of the probability of the truth of hypotheses.)

The experimental part of the plan is then executed to furnish the evidence for a test of original hypothesis. After he checks his work thoroughly each student then proceeds to see what he has learned about the particular problem under the given circumstances; by further reflection on the work he formulates the results for communication to others and examines his findings for future use in like or analogous situations. This is not a laboratory exercise, for the student is required to participate in original problems to learn how to deal with such problems by actually dealing with them scientifically. An example of this type of study is found in McKibben's work on tractor stability (6).

Under this method of teaching the student will learn to submit problems to theoretical analysis on the basis of underlying principles and mathematical methods; this will provide experience in making reasonable approximations and valid comparisons of variables. Those elements of a problem that defy theoretical analysis he will learn to evaluate empirically. Based on the problem situation, the student will be required to employ such principles as the following in reducing events and functions to mathematical relationships:

- Conservation of mass and of momentum, energy relationship (Newtonian Mechanics)
- First and second laws of thermodynamics and energy conversion
- Potential functions of field theory (heat transfer, electromagnetism, gravitation, etc.)
- Laws of circuit theory and electromagnetic phenomena

It will be necessary to assign problem situations that can be comprehended within a reasonable length of time, but the number of problems to be encountered is not the measure of success. The aim is to have the student gain confidence in the use of scientific knowledge and methods in order that he will enter his profession with concern for profundity instead of a belief in expediency through superficiality.

Method Cultivates Self Confidence

Creative learning will in no wise hazard proper topical coverage since all subject divisions in agricultural engineering can be interpreted on a few basic principles. While the amount of facts the students need for effective work in analysis varies, the main thing is that they develop the ability to deal with facts rather than memorize them. In order to afford students the freedom to practice imagination with learning and the time to integrate the subject divisions in agricultural engineering, textbooks should serve only as a source of typical examples and as reference material to encompass the scope of professional endeavors. To study these texts intensively directs unnecessary attention to present methods, which are being (or should be) antiquated, at the expense of training in imaginative thinking.

The greater competence in the utilization of scientific knowledge offered by this method of instruction will produce professional men of confidence, who will not only face problem situations aggressively and effectively but the men with this greater power of reasoning will create other problem situations that demand solutions—the essence of an advancing profession.

Graduate Study

Professional leadership requires men of broad interests, sound judgment and clear perspective for unceasing appraisal of methods, developments, efforts and proposals, as well as for the responsibility to the contribution of worthy ideas to the total human enterprise (5). This combination of responsibilities requires the highest type of training available and for this reason the academic phase of the agricultural engineering profession must administer vital graduate programs.

The productive activities of agricultural engineering are a complex of science, engineering and experience. Not only must the effective worker prevent gaps between the output of the scientific disciplines and engineering applications, but

. . . Training

he must also formulate knowledge of nature pertinent to the engineering of systems in order to increase the ease of its transmission and thereby the utility of this knowledge(1) Fig. 1. He must be an engineering scientist to the extent that he translates these data into idealized systems—structures, machines, processes, circuits, etc. But because there are force fields and interactions that are either unknown or cannot be analyzed, scientific training supplemented by practical experience (the art of engineering) fills the gap between the results of analysis and the actual system. Extrapolations from analogies and a sense of the magnitude of variables are requirements in this endeavor. Therefore, effective problem analysis and efficient synthesis of solutions necessitate that the engineer has a clear understanding of the nature of the several forces, energies and materials; by this he can readily perceive alternatives and evaluate the significance of ideas.

The uniqueness of engineering problems in agriculture amplifies the demands placed on the professional engineer in this area. First, there is the necessity of integrating the response characteristics of biological systems or a knowledge of the life sciences with the treatments interpreted by the physical sciences. Secondly, in many instances advancement in technology means the substitution of a mechanical device for the facility of the human hand. While this connotes complexity and refinement in design, such devices must be economically practical for enterprises that demand the use of this device even less than one week per year.

Objectives of the Graduate Program

The scope of learning implied in the above requirements for forceful workers and leaders in this discipline is tantamount to the acceptance of the fact that only a part of this competence can be obtained by the student during the time allotted to graduate study. Accordingly, the primary concern of a graduate program in agricultural engineering must be to impart to the student *(a)* an appreciation of knowledge, of where it lies and sufficient confidence in his ability to seek it out for a critical study of the various problems as they arise, and *(b)* a direction to his interests and scholarly aspirations so that he may dedicate his life's work to advancing this profession.

To achieve the first objective it will be necessary that the student obtain a real appreciation of the unity in scientific knowledge: that but a few basic concepts and mathematical principles serve as the common theoretical base for all interpretations of natural phenomena. This requires leading the student through an advanced level of physical theories in order that he may readily appreciate the analogies among the various formulations in field theory (dynamics, electromagnetism, thermodynamics) as well as a background in quantum physics, Fig. 2. This is the more important because after leaving formal study seldom do men enter into higher levels of knowledge.

Because existing concepts are formulated mathematically and since the objective of science is to establish expanding knowledge on either old or new mathematical principles, it is quite by necessity that creative workers in agricultural engineering should obtain as early as practicable an understanding of advanced mathematics. Also, competence in advanced mathematics will encourage and permit the individual to read and comprehend as well as enhance his verbalizations in the various branches of science.

Since the theories in the life sciences are based on concepts common to physical and chemical theories, it seems that in the perspective of professional training formal study should be concerned primarily with the mathematical and physical disciplines. The acquisition of techniques and general knowledge in the biological sciences can in the main be relegated to the student's progressive and continual self-study.

Some engineering sciences are needed to provide training in the application of theory to idealized systems and apparatus. Theory of probability and statistical methods must be included for their interpretation of the nature of events and as the basis for formulating efficient experimental plans and valid inferences from experimental data. Technology courses should be relied upon only for the contribution to training in techniques and analysis of existing applications pertinent for a background of professional endeavors.

Research and training in reasearch contribute greatly to the second objective stated above. Through instruction in the instrumental aspects of scientific research, the student acquires competence in the techniques peculiar to this profession; likewise, he becomes familiar with the problems and the methods of analysis and applied principles. Experience in research will be obtained from prosecution of individual researches pertaining to problems of professional interests. While a student the individual will have the opportunity to enjoy some success in the solution of these problems and by association with men of common interests he will find that community of spirit sufficient for a dedication of his life's work.

While this discussion has been directed to the integrated objective of a total graduate program, administration should be in two parts. Based on the B.S. degree in agricultural engineering, which includes mathematics through a first course in differential equations, physics and engineering sciences, the following course listing should fulfill the requirements for strong M.S. degree programs.

COURSES FOR MASTER OF SCIENCE DEGREE

REQUIRED COURSES	Semester Credits
Research in agricultural engineering	6
Seminar	2
Advanced calculus	6
Intermediate physics I, mechanics and heat	8
Intermediate physics II, electricity and magnetism	4
APPROPRIATE COURSES	
Special problems	
Instrumentation for agricultural research and processing	1
Soil physics	4
Physical chemistry	6
Plant physiology	4
Experimental stress analysis	3
Introduction to modern physics	3
Nuclear physics I	4
Experimental statistics for engineers	6
Fundamentals of soil mechanics	3
Theory of probability	3
Advanced differential equations	3

In the main the selection of courses beyond those listed as required depends somewhat on the student's interests and the nature of his thesis research. However, the student should not be too concerned about specialization at this level of graduate study. Statistics should, with few exceptions, be a regular requirement and whenever possible an introduction to modern physics should be included.

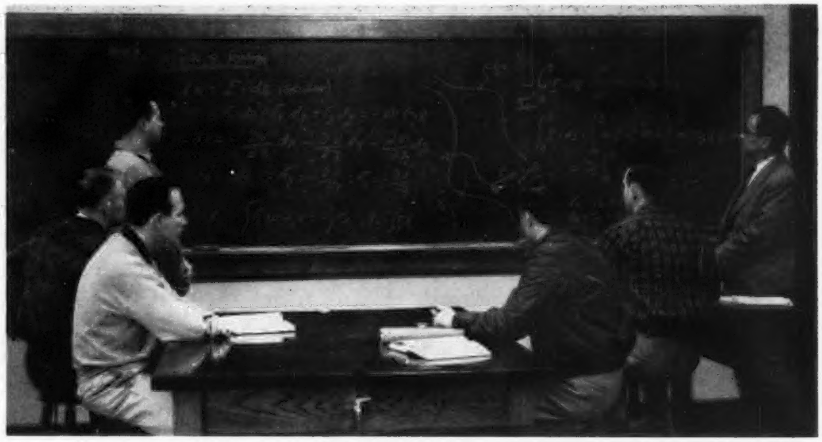


Fig. 2 Instruction in generalizations involving field theory and its relationship to Newtonian mechanics

The course work and standard of competence suggested for the M.S. degree would prepare the student well for more self-study and less formal classroom work. He would be prepared to read the literature and textbook material discriminately, would understand the mathematics employed, realize the pertinence of the subject and interpret properly the sequence of presentations. Therefore, with counselling, the student would learn more efficiently by greater reliance on his own ability, initiative and library resources than by following the routine of course work presentations. This suggests that a minimum of courses be required for the Ph.D. degree and that they be limited to those presentations which generalize the conceptual and theoretical forms of knowledge as conducted by a stimulating instructor. The student should be allowed maximum time for research and freedom for conscientious self-development. Again the final decision is to be based on that program of study having most meaning in a lifetime of work and learning.

The following list of courses are considered most appropriate to the *total* graduate program leading to the Ph.D. degree in agricultural engineering:

REQUIRED COURSES	Semester Credits
Research in agricultural engineering and seminar	
Instrumentation for agricultural research and processing	1
Advanced calculus	6
Intermediate physics: mechanics, heat and electromagnetism	12
Introduction to modern physics	3
Experimental statistics for engineers	6
Complex variable theory	3
Advanced general physics	6
Physical chemistry	6
Partial differential equations	3
OPTIONS	
Agricultural process engineering	3
Analysis of function and design of farm machinery	3
Theory of drainage, irrigation and erosion control	4
Analysis of function and design of farm buildings	4
Soil physics	4
Advanced soil physics	4
APPROPRIATE COURSES	
Special problems	
Plant physiology	4
Experimental stress analysis	3
Advanced engineering thermodynamics I, II	6
Nuclear physics I	4
Statistical mechanics	3
Fundamentals of soil mechanics	3
Theory of probability	3
Fundamentals of servomechanisms	4
Operational mathematics	3
Advanced algebra	3

Who should be encouraged to engage in this graduate program? Anyone who has the confidence that his mind is big enough to try to encompass the whole of human knowledge and experience by shrinking them in wisdom—the use of principles to swallow up details.

The student who has pursued with scholarly intent the program of study to the Ph.D. degree outlined above will have been exposed to the basic unity underlying the whole of scientific knowledge and should appreciate the possibilities of its applications. With such a mental inventory of knowledge his imagination should flourish with fundamental ideas as alternatives in approaches to problem situations. He will have a comprehensive appreciation of the opportunities and responsibilities for agricultural engineering, its relation to the total social enterprise, and the ability to communicate with other scientific and professional disciplines—essential requirements for professional leadership.

With regard to the future of the agricultural engineering profession it is important that the above program of study should not be considered appropriate for some sort of a "mental giant" only. The reality of this matter is, that if agricultural engineers do their job properly with the undergraduates it will be found that not only a fair percentage of them will want to take the outlined graduate program but also nearly a like number will be highly successful at it.

References

1 Boelter, L. M. K. A discussion of engineering teaching. AGRICULTURAL ENGINEERING 28:11, 512-516, 1947.

2 Brandeis, Justice. Definition of a profession. Rotarian, October, 1954.

3 Committee on evaluation of engineering education. Journal of Engineering Education 45:1, 40-66, 1954.

4 Green, R. B. Education in the sciences. The Scientific Monthly 79:1, 40-44, 1954.

5 Hustrulid, A. Objectives and standards in graduate instruction. Unpublished paper presented at ASAE meeting, Pittsburgh, Pa., June, 1953.

6 McKibben, E. G. Mechanics of the farm tractor chassis. Tractors and their power units, chapter 18. Barger, E. L., et al. John Wiley & Sons, New York, N. Y., 1952.

7 Pinches, H. E. Tomorrow's agricultural engineers — their opportunities. AGRICULTURAL ENGINEERING, 38:7, 1957.

8 Ver Plank, D. W. and Teare, B. R. Jr. Engineering analysis. John Wiley & Sons, New York, N. Y., 1954.

9 Whitehead, A. N. The aims of education. MacMillan, New York, N. Y., 1929.

. . . Infiltration Patterns

(Continued from page 664)

be estimated, some refinement can be obtained by accounting for this effect in the derivation of the equations and in the application of the results of the least-squares analysis. For information about field techniques and procedures in the evaluation of irrigation systems, reference is made to Criddle et al. (2).

Summary

A method is presented whereby water absorption patterns for border or furrow irrigation systems are evaluated from a limited number of relatively easy-to-take field measurements. The method can be employed in the evaluation of surface irrigation systems or in studies to determine the effect of certain factors on infiltration behavior of relatively large areas under field conditions.

References

1 Burgy, R. H. and Luthin, J. N. A test of the single- and double-ring types of infiltrometers. Trans. Amer. Geophys. Union, 37, 189-192, 1956.

2 Criddle, W. D., Davis, S., Pair, C. H., and Shockley, D. G. Methods for evaluating irrigation systems. Agriculture Handbook No. 82, Soil Conservation Service, U.S.D.A., 1956.

3 Hall, W. A. Estimating irrigation border flow. AGRICULTURAL ENGINEERING 37, 263-266, 1956.

4 Humbert, R. P. Water distribution studies in the Hawaiian sugar industry. Hawaiian Planter's Record, 54, 211-227, 1954.

5 Schiff, L. The effect of surface head on infiltration rates based on the performance of ring infiltrometers and ponds. Trans. Amer. Geophys. Union, 34, 257-266, 1953.

6 van Uven, M. J. Mathematical treatment of the results of agricultural and other experiments, 2nd Edition, Noordhoff, Groningen, The Netherlands, 1946.

. . . Fertilizer Placement

(Continued from page 661)

The handling of fertilizer materials looms large, because of increased consumption throughout the nation. The 20 million tons used annually poses labor-saving problems for the engineer, both as to storage and for field placement. This problem must be considered in relation to the type of material and the applicators used. Granular forms of dry type fertilizers offer advantages in the mechanization of these problems. The National Joint Committee on Fertilizer Application has made outstanding contributions to techniques in fertilizer placement. A debt of gratitude is due this Committee for information on current research and field practice.

In the years ahead continued progress will depend on sound programs of basic research in the soil and plant science fields. This must be supplemented by continuing achievements of industrial chemists and engineers in developing fertilizer materials and suitable mechanical equipment designed to meet successfully the evermore rigid specifications which basic research uncovers. With this, a properly developed extension program is needed to carry new developments to the field for the betterment of farm crops and management. This type of continuing program will result in the improvement of mechanical equipment, which will permit a better integration of fertilizer placement with seedbed preparation, planting practices, weed and pest control methods and other field crop practices.

References

1 Research is key to chemical growth, *Financial World,* Vol. 106, No. 12, pp. 3-5, September 19, 1956.

2 Shaw, Byron T. Fertilizer application in future, What's New in Crops and Soils, Vol. 8, April-May, 1956.

3 Henderson, D. W., Bianchi, W. D. and Doneen, L. D. Ammonia loss from sprinkler jets, AGRICULTURAL ENGINEERING. Vol. 36, No. 8, pp. 398-9, June, 1955.

4 Lorenz, O. A., Bishop, J. C. and Wright, D. N. A comparison of the fertilizer value of gaseous, liquid and solid forms of ammonia-containing nitrogen compounds. Proc. 31st Annual Meeting of the National Joint Committee on Fertilizer Application, 1955.

5 Merrill, R. M. What's new in fertilizer application equipment, *Plant Food Review,* Vol. 2, No. 1, p. 4, 1956.

6 Fertilization by airplane found helpful on Hawaiian plantations, *Sugar,* Vol. 51, No. 8, p. 38, August, 1956.

7 Flying jeep for agriculture and general purposes, *Engineering* (London), Vol. 182, No. 4722, p. 316, September 7, 1956.

Educational Conference

AN EDUCATIONAL conference will be held October 31 to November 2 at Edgewater Beach Hotel, Chicago. It is sponsored by the Engineering Manpower Commission of Engineers Joint Council; Scientific Manpower Commission; National Science Foundation; National Research Council; and Western Society of Engineers. The purpose of the meeting is to update facts on "Engineering and Scientific Education — Foundation of National Strength."

Advance program will be available October 1st from Western Society of Engineers, 84 E. Randolph St., Chicago, Ill., or Engineers Joint Council, 29 W. 39th St., New York 18, N. Y.

Direct Commissions Open in Technical Fields

THE Department of the Army currently has a program to appoint, as Regular Army officers, up to 200 outstanding specialists in certain critical, technical fields. This program is known as "Project 200." While agricultural engineering is not specifically listed as a critical field, many members of the profession possess qualifications for consideration in the program. Specialists are desired in the following, or closely allied, fields:

physics	chemistry
nuclear physics	communications engineering
electrical engineering	mathematics
electronic engineering	bacteriology
electronic data processing	meteorology
aeronautical engineering	psychophysiology
civil engineering	health physics or radio biology
nuclear effects engineering	hydrology
mechanical engineering	operations research
chemical engineering	guided missiles

Prior military service is not a requirement for appointment. Provision is made for constructive service credit to give individuals a position on the promotion list appropriate to their ages. Those selected must be citizens of the United States and must be able to complete 20 years of commissioned service by their 55th birthday. Education and experience criteria are as follows:

a. Bachelor's degree plus five years of experience, or

b. Master's degree plus three years of experience, or

c. Doctor's degree.

Interested individuals may obtain detailed information concerning "Project 200" from the Adjutant General, Attn: AGPB-A, Washington 25, D.C.

. . . Energy Requirements

(Continued from page 657)

Long-Term View

For this period we need first to study more carefully the character of our energy resources and their contribution to our economy. Despite all the assertions being heard currently about the ability of abundant low-cost energy resources to stimulate industrialization and increase wealth, we actually know very little about the role these resources play. We know that far more is required to achieve material wealth than an abundance of energy. This becomes obvious when we note that among the least developed countries of the world there are many with very rich natural energy resources.

In any event, a fundamental study is required to determine the way in which energy has contributed and can contribute to the economic growth and welfare of our society. We must seek those factors other than the mere existence of energy resources that have led to the intensive development of these resources.

The elements that have determined the proportionate contribution of each fuel source and the balance of total energy in combination with other factors of production in our own economy need to be better understood. Even more careful analysis will be required of the likely impact of these important factors on the future of our economy.

Second, we need a thorough, careful geological survey and inventory of our reserves of conventional energy resources to help us determine the cost at which these resources can be made available. Ultimately our known fossil fuel resources will become exhausted so that new resources, as yet unknown, will have to be found and developed. But there is considerable elasticity in existing resources. One of the important areas for research is the possibility of extending their life without inordinate price increase through the application of new techniques to the further proving in and recovery of their deposits. But we cannot evaluate the urgency of our need, and the competitive cost threshold for new energy resources if we do not have sufficient, reliable data to evaluate presently existing reserves. Such data, which we do not have today, would also help us to determine the likely contribution of each fuel to our total energy supply. Such data are indispensable to a rational development of technical knowledge and productive facilities for the most efficient use of energy sources, and to furnish guidance to the establishment, where needed, of effective government resources policies.

Third, in our preoccupation with the development of atomic power — power by fission — for the relatively near future, we are likely to forget that for a period only somewhat more remote other new sources of energy may be coming to the forefront. Not only fission but fusion and solar energy currently offer promising prospects for new resources for the long term. Fission is, at present, getting and, perhaps, should get the most attention. But the technological problems in the development of fission energy for safe, competitive use are so difficult that the other two sources ought not to be overlooked. Greater attention, it would appear, could be given to the question of how to distribute our pool of manpower and resources for research and development among these three sources of future energy supply so as to reconcile and serve best the combined interests of present and future generations.

Fourth, more critical analysis could beneficially be applied to projections of our future energy requirements. One of the possibilities that has attracted little or no attention is that of reaching a relatively static equilibrium in energy requirements. Our assumption of a constantly expanding economic system, with ever-increasing energy requirements, makes a statement of this kind sound like heresy. But, heresy or no, the possibility is real. One need only examine 100-year projections made by others to realize the care with which projections about the future in this field need to be carried out and the skepticism with which the results of such projects should be viewed.

Thirty and 40 years ago, some petroleum geologists were warning against the complete exhaustion of America's petroleum reserves within 20 years at the then current rates of petroleum production. The great English economist, Stanley Jevons, in his book "The Coal Question," published in 1865, took as his base actual coal consumption of over 80 million tons in Great Britain in 1861. From this base he projected figures —carried out at the then indicated compound rate of growth of 3½ percent — of 2,600 million tons as the requirements in 1961. That the actual consumption in Great Britain in 1961 will be of the order of 8 percent of that projection, and the American petroleum industry has continued to the present time to supply our expanding petroleum requirements, speaks, I believe, conclusively for the observation that I have just made.

It would be interesting, I believe, to examine a 100-year energy projection for the United States. Let us assume that the Census Bureau projection of United States population of 215 million in 1975 is reasonable. Then let us assume that population will continue to grow at a rate of 1½ percent per year compounded to 2000, that the rate falls to 1¼ percent in the period 2000-2025, and falls again to 1 percent in the 25 years between 2025 and 2050. If energy use per capita remains constant at the 330 million Btu per capita level projected by some authorities for 1975, energy requirements will grow from 42×10^{15} Btu in 1956 to 75×10^{15} in 1975, and to 103×10^{15} Btu, 141×10^{15} Btu and 180×10^{15} Btu in the years 2000, 2025 and 2050. In other words population increase alone can result in a growth by 2050 to almost 4½ times our present energy requirements. If, in addition, from 1975 on energy use per capita increases 1 percent per year these figures will be 132×10^{15}, 231×10^{15} and 379×10^{15}, respectively, or at the end of the period annual requirements will be nine times the present level or the equivalent of over 14 billion tons of coal.

Projected requirements of such magnitudes need to be examined through triple skeptical filters. Because if they should eventuate, they will pose very serious problems to our economy. It is important, therefore, that we study these longer periods more intensively to evaluate soberly and realistically the likely order of magnitude of our energy requirements and to visualize, even if only in broad outline, the magnitude of the problems to be solved.

Immediate View

The questions I have just outlined all deal with important aspects of the energy problem in the context of the long future. But, because this is the context, there is leeway in the time schedule for working on the problem. That is not the case with the pressing questions affecting the immediate energy picture in the United States. In dealing with this shorter range period I am confining myself to the next two decades; and because I have elsewhere studied 1975 figures I would like to discuss the 1975 picture as representative of the decade of the 1970's. Also, I shall address myself only to that portion of energy production and use which is represented by electric power. This enables me to speak of a field in which I feel reasonably qualified. As a topic for discussion electric energy also has a special appeal because it represents the fastest growing form of energy use in the United States and seems destined to remain so for a long time to come.

Electric Energy

Examining now our electric energy picture for the two decades ending with 1975: In 1956 the utilities in the United States generated slightly over 600 billion kwh. Using techniques that we are accustomed to apply in projecting growth in my own company, I believe the corresponding figure for the country in 1975 will be about 2,000 billion kwh. Of this total the industrial consumption represents 900 billion kwh, and this is the important figure. This will result from an increase, for example, between 1953 and 1975 of only 8 percent in the number of man-hours worked, but with a continuation of the long-term upward trend in output per man-hour, so that the 1975 worker with fewer hours on the job than his predecessor in 1953 will be much more productive.

The generating capacity required to produce this energy will be close to 460 million kw. This contrasts with the installed 1955 capacity of under 114.5 million kw, and the 1956 capacity of slightly over 120 million kw. The fuel to produce the 1975 energy may reach a figure equivalent to about 750 million tons of bituminous coal compared to about 280 million tons in 1956, with coal itself, as I shall show in a moment, accounting for over 475 million tons.

These are startling figures. Yet they are not at all unrealistic. They assume continuation of the present population trends at least to 1975 and an increase in energy required by 1975 not only to take care of a population in excess of 200 million, but the increase that will be experienced if we continue for this period the present pattern of our social-economic system — the continuing rise in the welfare level.

This naturally raises the question, "Can we in the brief span of 20 years bring about the staggering increase in electric energy producing facilities to close to four times

. . . Energy Requirements

that of 1956 and can these facilities be made to produce the giant increase in energy: generate, transmit, and distribute it?" Even more important, can the rate of growth in demand for this vast increase in energy use be sustained? If it is possible, is it more or less inevitable, or are there difficulties ahead? How serious are these; can they be removed? What role can or should research play in that removal? And what part of this research is likely to be continued and carried through in any event? What phases of research are in danger of being overlooked and require special attention if the course projected is not to be blocked by ignorance and uncertainty?

These are questions we have been studying for many years. I believe that within the time span covered by my terms of reference this demand can be brought about, the facilities can be provided, the fuel and other energy resources brought together, the energy generated and transmitted and distributed and the utilization accomplished if the basic historic factors such as availability of power in substantially any quantity needed by an area or region; cost of energy vis-a-vis other items in the economic scheme of things; and the continued development of electric utilization devices and methods all continue without substantial change.

These are rather stiff assumptions. There are certainly indications that in the past these conditions have not always been given enough weight in projecting expansion and research and developmental programs. And no reliance can safely be placed on the prospect that these developments will automatically be taken care of in the future; at least one cannot be complacent about it.

Primary Energy Needs

Let us examine our primary energy needs in the next 20 years from the point of view of the 600 billion kwh used in 1956 and the projected 2 trillion kwh in 1975. Let us examine the various components of primary energy supply, the problems encountered in meeting such a projected growth, and consider what, in each case, research has to offer and along what special lines research might be directed.

What will be the sources of energy? It seems clear that in the period under consideration tidal and wind power are likely to bring only negligible contributions, and solar power—whether by direct collection or by the photosynthesis route—only very small contributions to the energy supply. Hydro, which in 1956 accounted for not quite 121.8 billion kwh, or just slightly over 20 percent, will by 1975, in my judgment, account for not much more than double that figure, a total of 250 billion kwh, or one-eighth of all generation. The balance of 1,750 billion kwh would have to be thermally generated.

Thermal Power Demands

This balance of 1,750 billion kwh to be generated by thermal power will either employ nuclear or fossil fuels. I shall make a number of observations later about nuclear energy. Except for the inroads of nuclear fuel, there seems to be little doubt that coal will have to pick up an increasing proportion of the energy burden. My own evaluations indicate that by 1975 natural gas, which in 1955 accounted for 96 billion kwh, and for 22 percent of the total energy generated, will increase its share of total generation to about 200 billion kwh, but that figure will represent only about 10 percent of the 1975 figure of 2 trillion kwh. Similarly, oil, which in 1955 accounted for 36 billion kwh, or 6.7 percent of the total, will by 1975 account for about 90 billion kwh, or roughly 5 percent of the total. And if, as I shall later develop, nuclear power can at best pick up somewhere a little over 7 percent but less than 10 percent (in my opinion nearer 7 than 10) of the total production of 2,000 billion kwh, coal will be required to pick up about 65 percent of the total, or 1,300 billion kwh. And at an average performance of 9,000 Btu per kwh, with coal of 12,000 Btu per pound heat content, this will require in 1975 utilization of over 475 million tons of coal. This is not only an increase of some 340 percent over the 1955 figure of 144 million tons, but is actually more than the 465 million tons of total bituminous coal produced in the United States in that year.

I do not believe that this presents a serious supply problem, even on a highly economical basis, as long as the present trends in mechanization and research towards improvements of mining methods continue.

The prospect of upgrading the volatile component of coal and making it available for further chemical processing or reprocessing, and by that step downgrading the component destined for combustion and the generation of heat, requires further study to achieve more efficient utilization of valuable natural resources and reduction of energy costs. And work on underground gasification, which has not yet yielded favorable results, ought not to be dropped. Rather it needs to be more thoroughly explored, particularly if seams of coal too poor to mine by present technologies should have to be brought into use.

Nuclear Fuels

I have said little as yet about nuclear fuel. Everyone knows that atomic power has been technically achieved. It is in the field of competitive power—where nuclear fuel is asked to meet the test of competition with other forms of energy—that there still remains a big question. The question here is really one of time. Eventually as the cost of atomic power is brought down, and as the cost of conventional fuels goes up due to the exhaustion of more economical reserves and the rapidly rising demands for such fuels, the two cost curves are likely to cross each other; this will happen at different times in different parts of the world. But as to when that is going to happen here still remains a big question. In spite of the large amount of work that is going on in the various national laboratories and in industrial institutions to help develop atomic power, and in spite of the number of large reactors for the production of atomic power that are under way or in immediate prospect in the United States or abroad, there is not a single one that is, or can be expected to be, truly competitive with its more conventional fuel equivalent that has been, or could be, installed in the same area in the United States. Of course, the higher the costs of conventional fuels the nearer to meeting the competitive test does atomic power become.

However, we need to be mindful of the fact that atomic power is a very young technology; we shall, therefore, have to try out a variety of research and demonstration projects before economical nuclear power can possibly became a reality. In planning and organizing research for this field some new thinking and new concepts may be needed; this may lead to ideas that have not been commonly utilized in the past in our many-sided technological developments. Here, in atomic power, we have to face up to the question of the desirability and perhaps even the need of telescoping a long-term program of research and development for the sake of the longer term domestic need and, for the more immediate present, from the standpoint of maintenance by the United States of its position as world leader in that field. A vigorous program and bold approach, involving, perhaps, partnership arrangements between industry and government, to hasten such research development have to be faced up to and adopted in some cases or expanded in others.

Reviewing all the relevant factors, it seems quite clear that the effect of the expansion of atomic power generation on over-all sources of energy in the United States for the next 20 years is likely to be almost negligible between now and 1965, and only slight over the following 5 years; it will, perhaps, represent a significant figure in the succeeding one-half decade. Over-all, I believe it cannot account for as much as 10 percent of the total electric energy by 1975. I realize that this is lower than sober estimates made by others; I do not ignore these.

But my own best judgment, and the lower figures for nuclear power that this leads me to, are based on:

(a) the many difficult technical problems still to be overcome, particularly in concepts that give most promise for leading to competitive atomic power;

(b) the vigorous competition that I believe will come from coal in the United States;

(c) the long lead time required for bringing in any power plant involving technical change or substantial improvement; this is particularly telling in view of the acknowledged need of reactor designs to go through not less than two, and probably three, generations before we can hope to have truly competitive plants in the United States;

(d) the heavy annual operating losses involved in bringing into operation a generating unit of substantial size when its production costs are at a competitive disadvantage even as small as 1 mill per kwh.

All this leads me to the conclusion that nuclear installations in operation in 1975 will, at most, account for between 7 and 10 percent of the total energy generated, and if a single figure is to be used I would place it at 7.5 percent or 150 billion kwh.

Energy Utilization Problems

I would like to make a brief observation about utilization and its problems. The increase in energy utilization in the next quarter century of the magnitude indicated in this discussion obviously presupposes the existence and use of the necessary utilization devices in the homes, in commercial and industrial establishments, on the farms, and in other operations. There is in the country —and the world for that matter—an accumulated momentum which can be expected to carry forward in the development of electric utilization equipment; but in some fields perhaps not enough attention has been given to electric utilization. Household heating for year-round conditioning is in that category. Eventually most homes and most establishments for habitation will be electrically heated and conditioned, or will operate on a combination solar-electric system. But whether a straight electric system or a heat pump or solar heat in combination with either of these means is utilized, all of them sooner or later come up against difficulties that could be removed by an economical system of storage. Here, in particular, therefore, fundamental work could be carried out to advantage.

The area of particular interest to this group in which there are substantial opportunities for greatly expanding the beneficial application of electric energy is in agricultural production. At the present time agricultural surpluses represent one of the major political-economic problems confronting the country. However, population growth over the next several decades, if current demographic projections are valid, can avoid the imposition of increasing pressure on our agricultural resources only if the trend of rising productivity for our agricultural economy can be continued. In the achievement of this objective, electric energy can and, I believe, will be called upon to make an important contribution.

The difficult task of making electric energy universally available to the farms has been substantially completed. In the quarter century, 1930-55, the number of electrified farms rose from some 650,000 to 4.5 million or from about 9 to 95 percent of the total farms. However, the primary result of making available electric energy to the farms of the United States during this period has been to bring to the farm home the comforts and conveniences of urban living. I realize that this is a broad generalization. But it is indicated by the relatively narrow difference between average annual farm and residential kwh consumption. On farms east of the 100th meridian, where irrigation pumping does not distort the data significantly, average annual consumption per farm has grown five-fold in the period 1930-1955: from 745 to 3,650 kwh. This compares with a five-fold increase from 547 to 2,751 kwh for the average residential customer in the United States in the same period.

Agricultural Applications.

Non-domestic farm use of electric energy has been relatively small. It has been estimated that in 1956 the average farmer used less than 1,500 kwh for production compared with 20,000 kwh consumed by the average industrial worker. If such use has so far not been startling, it has not been insignificant and, what is important, it is growing.

The application of electricity on the farm has so far been largely confined to areas in and around farm buildings where it could reduce the time and physical effort required for farm chores such as material handling and repairs, and make possible environmental control.

The increase in farm mechanization—utilizing mainly non-electrically driven equipment—and the need for prompt repair of equipment has increased the importance of the farm repair shop and the use of electric tools. The application of electric devices for environmental control to destroy insects and pests, for ventilation, heating and cooling has contributed to improvements in both the quantity and quality of farm commodities such as poultry and dairy products. The use of mechanical devices for such activities as barn cleaning, silo unloading, animal feeding and cow milking has released additional time previously devoted to such chores enabling the farmer to undertake additional production activities. Other equipment has indirectly contributed to increased field productivity. For example, the hay drier, by making possible early hay cutting, can increase the yield per acre by reducing exposure damage and harvesting losses from leaf shattering when raking and loading. This, combined with the increased protein content and digestibility of the feed as a result of early cutting, can lead to a 25 percent increase in milk production per acre of hay.

The potential contributions of electric energy on the farm to control environment to protect the product against deterioration and to perform the chores are, however, still in the early stage of development. The increasingly wide-spread realization of these potentials and recognition of their advantages will contribute to significant expansion of farm consumption of electric energy.

There have been recent indications that the application of electric energy on the farm can be extended beyond the limits of farm buildings to contribute more directly to field productivity. As an example electric soil treatment tests are being conducted in Arizona to reduce the alkali content and increase the permeability of hard-pan soils for the cultivation of lettuce, Cardinal grapes, melons, citrus fruits, wheat and other grains. A side benefit in these tests has been an apparent reduction in root damage caused by nematodes. Another example is resistance heat that is being employed in seed beds in Oklahoma to speed the incubation period for sweet potatoes. Numerous other possibilities such as the use of electric fence gates combined with high frequency sound for the round-up of cattle may seem like science fiction, but it is of such imaginative stuff that the practical tools of tomorrow are made.

On the more solid side, the extension of irrigation to humid areas offers another significant possibility for expanded use of electric energy. In humid areas, even in years of normal rainfall, the natural moisture frequently is not distributed throughout the year for the maximum benefit to crops so that it is often deficient during the most critical growing periods. Controlled irrigation in humid areas to regulate moisture in accordance with crop needs rather than dependence on the vagaries of weather shows promise of signficantly improving yields.

These represent important potential applications of electric energy to increase farm productivity over the next several decades. However, the capital required to finance the frequently high first cost of the necessary equipment can present a difficult impediment. Here is a challenge to the agricultural engineer. There is an important need to develop and design equipment that can be manufactured and sold at low initial cost and can be operated and maintained with ease, simply and inexpensively. The availability of such equipment can make a major contribution to the farmer's ability to harness electric energy, to ease the physical burden of farming, improve his own productivity and to satisfy the demands of a growing population for more and higher quality agricultural products. It has been estimated that farm consumption of electricity will grow more than three-fold in the next 15 years: from some 23 billion kwh in 1956 to 70 billion in 1971. This growth, however, is not automatically assured—far from it. It is contingent upon, and can be brought about by, an imaginative and continuous program of research and development which the members of the American Society of Agricultural Engineers can encourage and help bring into realization.

Student Member Transfer Contest Results

Fifteen student branches of ASAE entered the "Student Member Transfer Contest," which was inaugurated this year to encourage agricultural engineering graduates to join the Society at graduation time. Participating student branches provided ASAE headquarters with a list of spring and summer graduates, and this list was checked against membership applications received at ASAE headquarters to determine the percentage of graduates applying for Associate Member status in the Society.

The contest served to acquaint graduates with the advantages of early affiliation with the national organization of their profession and effected a savings for the graduates since their applications were received within the year of graduation, thus relieving them of the requirement of paying the Society's admission fee.

Participating student branches and their percentage transfer into the national organization were:

Student Branch	Percentage Transfer
Alabama	25
Georgia	92
Idaho	100
Illinois	100
Maine	20
Michigan	68
Mississippi	100
Missouri	37
North Carolina	75
Oklahoma	20
Oregon	80
Pennsylvania	67
South Dakota	50
Texas A & M	84
Virginia	100

ASAE Dues Reduced For Foreign Members

The annual dues schedule for non-citizens of the United States and Canada was modified by the Council of ASAE at its June meeting. The new schedule, effective January 1, 1958, will be as follows: Members under 27 years of age—$7.00; those 27 through 34—$10.00; and those 35 and over —$12.00.

Prior to January, 1957, foreign members were required to pay dues at one-half the rate established for citizens of the United States and Canada. In view of the higher mailing costs to foreign members, this dues reduction was canceled by the Council at the 49th annual meeting, June, 1956.

Subsequent reports from many members pointing up the extent of this action in terms of current currency exchange values led to a modification passed at the 50th annual meeting. Council members explained that this new action was prompted by the desire to encourage the exchange of agricultural engineering information with engineers in other parts of the world by making available at a more commensurate charge the membership services provided by the American Society of Agricultural Engineers.

The new schedule applies only to persons who certify that they are citizens and residents of countries other than the United States and Canada. United States citizens on foreign assignment will continue to pay in accordance with the regular schedule.

Ben Hagglund AE Scholarship

A new scholarship for undergraduate agricultural engineering students attending the University of California at Davis has been named the Ben L. Hagglund Scholarship. This is the first scholarship to be set up for a student majoring in agricultural engineering at Davis.

The first student to receive the scholarship is Malcolm A. Niles of Loleta, Calif. He is a sophomore student working for a B.S. degree in agricultural engineering. The money for the scholarship was made possible by farm machinery dealers in seven western states, Alaska and British Columbia, and will be open to any undergraduate student from the area who is studying agricultural engineering on the Davis campus. Preference will be given to students active in 4-H Club work.

Mr. Hagglund was a farm advisor in Santa Barbara county for five years. Then, following two years as a ranch superintendent, he joined the Caterpillar Co. When he died last year, after 25 years with the farm machinery firm, he was its Southwest sales manager. He joined ASAE in 1938 and in 1954-55 served as chairman of the Pacific Coast Section. He was raised on a farm in Iowa and was a member of the pioneer 4-H Club as developed in Page County, Ia. He graduated from Iowa State College with a B.S. degree in agriculture.

October, Membership Month

Awards Offered

October has been designated as "Membership Month" by ASAE headquarters. All section membership committees and ASAE members are urged to make a special effort to obtain new members during this period.

As an added inducement, ASAE headquarters will provide *each member* who turns in *two new membership applications* during the month of October with his choice of an ASAE lapel identification button or pin. Members submitting applications during this period are asked to identify their applications by writing the words "Application submitted by (member's name)" across the top of the application form. When the second application is turned in by the member, he should specify his preference of lapel button or pin.

Applicants will pay no dues until date of election at which time they will be invoiced for the regular admission fee and prorated dues for the balance of the year.

National Science Grant to Oklahoma State University

Effects of wind on Oklahoma's farm buildings, crops and land will be studied under controlled conditions with a National Science foundation grant to Oklahoma State University, Stillwater.

According to E. W. Schroeder, head of the agricultural engineering department, the grant will be used for research in micro meteorology. A 60-ft long low-speed wind tunnel, reportedly the first of its type in this area, will be installed to simulate natural wind effects under controlled conditions, so that studies can be made in the performance and design of light farm structures, ventilation of livestock shelters, cooling and preservation of farm crops, soil and water conservation and irrigation of cultivated crops.

The research, including the design and construction of the new wind tunnel, will be under the direction of G. L. Nelson, professor of agricultural engineering at the University.

1957 ASAE Journal Paper Awards

The following are the top ten papers published in AGRICULTURAL ENGINEERING during 1956. They are arranged in the order of highest scores as judged by the Committee on Paper Awards—J. M. Fore (chairman), W. H. Carter, B. L. Bondurant, J. E. Harmond, L. G. Johnson and G. A. Karstens.

Authors and titles of the five winning papers are W. F. McCreery and M. L. Nichols, "The Geometry of Disks and Soil Relationships;" F. W. Blaisdell and C. A. Donnelly, "Hood Inlet for Closed Conduit Spillways;" H. W. Sack, "Longitudinal Stability of Tractors;" F. Z. Blevins and H. J. Hansen, "Analysis of Forage Harvester Design;" and M. L. Esmay, D. B. Brooker and J. S. McKibben, "Design of Above-Ground Horizontal Silos."

Those receiving honorable mention are A. W. Clyde, "Disk Harrow Design Improvements;" W. E. Matson, M. C. Ahrens, J. V. Spencer and W. J. Stadelman, "Cooling and Freezing Pan-Ready Turkeys;" P. W. Manson and F. W. Blaisdell, "Energy Losses at Draintile Junctions;" H. E. Pinches, "Management Engineering in Agriculture;" and W. A. Hall, "Estimating Irrigation Border Flow."

Special Business Meeting Called For December

The ASAE Council has called a special business meeting to be held during the Winter Meeting in Chicago for the purpose of considering amendments to the ASAE Constitution. The meeting will be scheduled immediately following the general session on Tuesday afternoon, December 17.

The proposed amendment will affect Article C6, Sections 2 and 4; and Article C7, Sections 1, 3 and 4 of the Constitution. The essence of the new proposal was presented before each division steering committee during the 50th Annual Meeting and was enthusiastically received except for minor suggestions of modifications. Details of the new proposals are being developed in accordance with the recommendations of the steering committees and Council offered at the 50th Annual Meeting.

In compliance with the Constitution, the proposed amendment will be presented and discussed at the Winter Meeting, but may *not* be voted on at that time. If approved by those present, it will be mailed to cooperate members for action by sealed letter ballot early next year.

Iowa AE Field Day

Iowa State College will hold a sixth agricultural engineering field day at Ames, Friday, September 27. The program will feature field shelling and drying of corn, operation of heated and unheated-air driers, framing pole structures for maximum strength, some statistical materials on the accident rate among farm people, some tips on operation of milk tanks found through research work, and a chance for Iowa farmers to see results of irrigation experimental trials.

Movies on Bulk Handling

Two movie films on bulk handling techniques are available without charge from General Box Co., 1825 Miner St., Des Plaines, Ill. One film depicts the potato harvest in Maine. The other is a sound and color story of the harvesting, handling, storing and processing of green beans at the John H. Dulany and Sons Cannery in Fruitland, Md.

Silver Anniversary at Illinois

The 25th anniversary of the professional agricultural engineering curriculum at the University of Illinois will be celebrated during Home-coming week-end, October 18-20. A Silver Anniversary banquet and recognition program will be held in Latzer Hall on October 18. Agricultural engineers and agricultural engineering will be featured throughout the week-end.

London Building Exhibition

The Building Exhibition will be held for the fiftieth year at Olympia, London, November 13-27, Sundays excepted. The exhibition originated at the agricultural hall in Islington, and was taken over by the present management in 1895. It covers current development in more than fifty industries connected with building.

Special overseas brochures concerning this exhibition have been printed and a limited supply are available by writing to the American Society of Agricultural Engineers, P.O. Box 229, St. Joseph, Mich.

ASAE MEETINGS CALENDAR

October 17-18 — ALABAMA SECTION meeting, Decatur, Ala.

October 19—MICHIGAN SECTION, Michigan State University, East Lansing.

October 23-27 — PACIFIC NORTHWEST SECTION, Compton Union Bldg. State College of Washington, Pullman

November 8-9 — OHIO SECTION, University of Ohio, Columbus

November 15-16 — VIRGINIA SECTION, Blacksburg.

December 15-18—WINTER MEETING, Edgewater Beach Hotel, Chicago, Ill.

February 3-5—SOUTHEAST-SOUTHWEST SECTION meeting, Little Rock, Ark.

June 22-25 — 51st Annual Meeting, Santa Barbara Campus, University of California, Santa Barbara, Calif.

NOTE: Information on the above meetings, including copies of programs, etc., will be sent on request to ASAE, St. Joseph. Mich.

Blue Ribbon Awards for Annual Meeting Exhibits

Extension exhibits blue ribbon awards were presented to the winners at the 1957 Annual ASAE Meeting by F. W. Andrew, chairman of the committee on extension. Displays were provided by industrial and public service organizations all over the country.

Exhibits were displayed and judged according to type and class of entry. Classes included demonstration models, slides and film strips, publications (bulletins and periodicals), motion pictures, radio and television, extension methods, and textbooks.

The display of demonstration models was under the direction of B. F. Cargill. Winners in the public agency class were Keith Hinchcliff, University of Illinois, Urbana, with a demonstration model of a flexible split level farmhouse; Arthur Muehling, University of Illinois, radiant heated farrowing house floor; and B. F. Cargill, Michigan State University, clear span pole building. Beat the heat, by Reynolds Metal Company of Toledo, Ohio, and solar farm building, by Libbey-Owens-Ford Glass Co., Toledo, Ohio, were the winners in the industrial class.

Slide and film strip entries were in charge of D. M. Byg. Winners in the public agency group were "Diagnosing Your Electrical Ills," by D. M. Byg and I. P. Blauser, Ohio State University, Columbus; "Career Opportunities in Agricultural Engineering," by Harold V. Walton, Pennsylvania State University, University Park; and "Using Fire Extinguishers," by L. W. Knapp, Jr., Cornell University, Ithaca, N. Y. The industrial class winners were "Planning Your Farm Kitchen," by S. S. DeForest, *Successful Farming*, Des Moines, Iowa; "Tractors and Traffic," and "Set-Up For Upsets," by Kenneth Fiske, National Safety Council, Chicago, Ill.

D. W. Derber was in charge of the publications. The winning bulletins and periodicals in the public agency group were "Good Fences For Your Farm," by Carl Scheneman, University of Missouri, Columbia; "Live and Play the Electric Way with 'Happy'," by D. M. Byg, Ohio State University; "Planning a Machinery Storage Layout," by G. E. Henderson, University of Georgia, Athens; and "Information Leaflets," by F. W. Andrew, University of Illinois. In the industrial class the bulletins and periodicals winners were "A Survey of Solar Poultry Houses," by Everett Eakin, Libbey-Owens-Ford Glass Co., Toledo, Ohio; "Horizontal Box Silos," by Ivan W. Bigalow, U. S. Steel Corp., Pittsburgh, Pa.; and "Massey-Harris Farm Profit," by Lee Schwanz, Robin Press, Inc.

Movie awards under the direction of B. P. Hess, were won by three films in the public agency class and three in the industrial group. The public agency winners were "Engineering For Eddie," by Ohio State University, Columbus; "How Much Water," by Washington State College, Pullman; and "Fencing For The Future," by Virginia Polytechnic Institute, Blacksburg. The industrial winners were "A Story For the Editor," by New Holland Machine Co., New Holland, Pa.; "A Place In the Sun," by Libbey-Owens-Ford Glass Co., Toledo, Ohio; and "Man Made Rain," by Aluminum Ltd., Montreal, Canada.

Radio entries were in charge of Don Brown. Winners were L. W. Knapp, Jr., Cornell University, Ithaca, N. Y., in the public agency group; and K. V. Fiske, National Safety Council, Chicago, Ill., in the industrial group.

The extension methods winners, under the direction of R. L. Ricketts, were Harold E. Stover, Kansas State College, Manhattan; L. W. Knapp, Jr., farm safety specialist, Cornell University, Ithaca, N. Y.; Carl S. Winkelblech, Cornell University, Ithaca, N. Y.; and Paul Spurlock, University of Arkansas, Fayetteville.

J. P. Schaenzer was in charge of the textbook exhibits. Because of the wide range of subject matter and the time required to make a fair comparison of these works, no awards were made in this class, but some fifty books were on display.

Engineers General Assembly

A combined meeting of the Engineers Joint Council and Engineers Council on Professional Development will be held October 24-25 at the Statler Hotel in New York City. The morning program for October 24 will be on the evaluation of military service and its contribution to professional development. In the afternoon the role of the two-year post high school curricula in technological education in the next decade will be discussed.

The Engineers' Council for Professional Development is celebrating its twenty-fifth annual meeting.

Friday morning, October 25, the meeting will be devoted to the place of the engineer in industrial management. A panel of speakers representing large and small industrial organizations will discuss the need for management training for engineers and outline specific company programs. Trends in combining advanced engineering education with engineering employment will be presented during the afternoon session.

A limited number of copies of the preliminary program is available from ASAE headquarters.

Arkansas AE Students Win Academic Honors

The agricultural engineering students of the University of Arkansas received a scholarship award given by the College of Engineering for the highest grade point for the fall semester 1956. The award was presented at a recent engineering day banquet. James R. Kimzey, a freshman agricultural engineering student on a Caterpillar scholarship, tied for high grade point and was given a ten dollar award by Tau Beta Pi.

New NFEC Officers

The National Farm Electrification Conference announces the following officers and farm counselors for the coming year—W. J. Ridout, Jr., editorial director, *Electricity-on-the-Farm* magazine, was elected as chairman; H. S. Pringle, and H. H. Watson, respectively extension agricultural engineer, Federal Extension Service, USDA, Washington, D. C., and commercial engineer, Construction Materials Div., General Electric Co., Bridgeport, Conn., were chosen as first and second vice-chairmen. Russell Gingles, manager of the Farm Electrification Bureau, National Electrical Manufacturers Assn., was elected as secretary; and Karl H. Gorham, business manager of *Electricity-on-the-Farm* magazine, was named as treasurer.

Other ASAE members elected as farm counselors are J. C. Cahill, E. C. Easter, Dean Searls, A. W. Farrall, J. W. Martin, and W. C. Wenner.

EVENTS CALENDAR

September 23-25 — Sixth annual meeting of the *Standards Engineers Society*, Hotel Commodore, New York, N. Y. For more complete information write to Herbert G. Arlt, Bell Telephone Laboratories, Murray Hill, N. J.

September 23-25 — Twelfth annual conference of the *Petroleum Division of The American Society of Mechanical Engineers* will be held at the Hotel Mayo in Tulsa, Okla. Problems of the petroleum industry will be discussed by engineers representing all branches of operations.

October 14-18 — *National Hardware Show*, the Coliseum in New York, N. Y. Correspondence and requests for floor plans and other information should be addressed to executive offices of the National Hardware Show, Suite 1103, 331 Madison Ave., New York 17, N. Y.

October 17-19 — *National Society of Professional Engineers*, Grand Pacific Hotel in Bismarck, N. D.

October 24-25 — *Engineers General Assembly*, a combined meeting of Engineers Joint Council and Engineers Council on Professional Development, at the Statler Hotel, New York, N. Y.

October 31—November 1 — *Southern Farm Equipment Manufacturers, Inc.* meeting held at Radium Springs, Albany, Ga.

October 31—November 2 — *Conference on higher education in technology*, held by the Engineering Manpower Commission of Engineers Joint Council, Scientific Manpower Commission, National Science Foundation and National Research Council, Edgewater Beach Hotel, Chicago, Ill. The purpose of the meeting is to update manpower need and engineering education; to promote industry action; to focus engineers' own attention on education; to make engineers' point of view felt by the nation.

November 13-15 — *Eighth National Conference on Standards, American Standards Association, Inc.*, Saint Francis Hotel. San Francisco, Calif. The theme is Standards — Key to Progress and Profits.

November 13-27 — *The Building Exhibition* at Olympia, London, England. It covers current development in more than fifty industries connected with building.

Dov B. Krimgold, research scientist, Laboratory of Climatology, Buckhorn Farm, Woodbine, Md., has recently returned from a tour of duty with the Food and Agriculture Organization of the United Nations. His work with FAO was in the field of hydrology and included 13 months in Israel. He spent a short time in Yugoslavia and Holland where he delivered lectures on his work in Israel. He has been asked by the Israeli Government to return for another two years to begin in November, 1957.

Mr. Krimgold says that hydrology, particularly the agricultural phases of it, is being recognized the world over as one of the principal factors in agriculture, in land use, and in conservation.

Sol D. Resnick recently returned to the United States after completing a three year Point IV assignment in India.

William C. Fairbank, formerly application engineer for Food Machinery & Chemical Corp. in San Jose, Calif., has accepted a position as plant engineer for Bercut-Richards Packing Co. in Sacramento, Calif.

Morton W. Bittinger, formerly employed with consulting engineers, Thompson & Willis, Algona, Iowa, has accepted a position as assistant civil engineer at the Colorado A & M College in Fort Collins, Colo. His work will be in groundwater research.

J. L. Dirnberger, formerly with the New Mexico Extension Service, has accepted a position in the Rural Electrification Administration of USDA as farm electrification specialist. His headquarters will be in Denver, Colo.

Ted J. Nissing has resigned as agricultural engineer with the U.S. Ginning Research Laboratory, USDA, at Stoneville, Miss., to accept a position of research associate in agricultural engineering with the Experiment Station at Louisiana State University.

Charles G. Burress has been appointed Eastern regional manager for the Wonder Building Corp. of America, with headquarters in Harrisburg, Pa. Previously he was chairman of the agricultural engineering extension section of the Pennsylvania State University, and later worked as an automobile dealer in Pearisburg, Va.

Charles N. Hinkle recently received a Ph.D. degree from the University of Missouri, representing the agricultural engineering dept. as its first Ph.D. candidate. He has accepted a position as associate professor with the agricultural engineering dept. at South Dakota State College and will be in charge of the farm buildings section.

R. C. EVANS

Robert C. Evans has been promoted to the position of product manager in the sales dept. of the New Idea Farm Equipment Co. He joined the company in 1955, and prior to his promotion was senior project engineer. He will be in charge of hydraulic loaders, irrigation equipment, wagons and other company products.

Paul Kay, regional manager for Douglas Fir Plywood Assn., has accepted a position as general manager of a new United Wood Corp. plant being built in West Memphis, Ark., for the manufacture of a new wood product.

Raymond O. Oyler, assistant sales manager for New Departure Division of General Motors Corp., has recently been promoted to general sales manager. He has had 19 years of sales and engineering experience with the company. For many years he served New Departure in the midwest area, including fulfillment of the position of midwest region sales manager with offices in Chicago.

Alabama Section

The Alabama Section will hold a meeting October 17-18 at Decatur, Ala. The first morning will be devoted to registration, a tour of the Alabama Flour Mills, and a tour of the Wolverine Tube Co.

F. A. Kummer will preside at the Thursday afternoon session. Papers will be presented on the agricultural outlook by Foy Helms; equipment and chemicals for weed control by T. E. Corley and V. S. Searcy; 4-H tractor program by J. T. Gaillard; and tractor fuels by an engineer from an oil company. A boat trip on the Tennessee River will be made in the evening with dinner served enroute.

Chairman Joe Hixon will preside Friday morning and the program will be devoted to a business meeting followed by presentation of papers on what agricultural engineers can do for Alabama by ASAE Secretary J. L. Butt; a farm wiring workshop by W. R. Walker; plastic pipe for irrigation and water supply by Frank Shy; the role of irrigation in mechanized cotton production by Rex Colwick; and harvesting and storing silage by C. A. Rollo.

Pacific Northwest Section

The Pacific Northwest Section meeting will be held October 23-26 on the campus of Washington State College, Pullman. An interesting program has been planned for the ladies with luncheon meetings, tours, speakers and time to browse or rest.

Registration, a program and social hour will make up the first evening, Wednesday, October 23. Thursday morning, October 24, will be devoted to a general program. After a welcome by C. C. French, president of Washington State College, L. L. Madsen and H. W. Barlow from the staff of Washington State College will speak on what agriculture needs from the engineer and what the engineer needs from agriculture. Other speakers will include ASAE President Earl Anderson; K. L. Pfundstein, Ethyl Corp., Detroit; and C. H. Milligan, Utah State University. A tour to Potlatch Lumber Mill at Lewiston, Idaho, is planned for the afternoon. A student dinner, courtesy of R. M. Wade & Co., will be held at 6:00 p.m. with a business meeting and election of student officers following.

Four concurrent programs are also scheduled for the evening of October 24. N. R. Brandenburg will preside at the Power and Machinery program. Papers to be presented are on the experimental Ford typhoon tractor, by R. L. Erwin, Birmingham, Mich.; developing low cost methods of harvesting, ensiling, and feeding grass silage, M. G. Cropsey, Oregon State College; and testing of materials handling equipment, D. A. Randall, Hyster Co. The Soil and Water program will be presided over by D. L. Bassett. A panel discussion on developments in soil and moisture measurement and control is planned. Subjects on extension's irrigation education plan, small watershed program in the Northwest, and project planning for drainage will be covered.

Presiding over the Rural Electric program will be W. E. Salmon. Talks on materials handling on poultry farms, bulk milk coolers, and silage handling will be given, followed by election of Division officers. The Farm Structures program will have as speakers, G. G. Marra, Washington State Institute of Technology; G. B. Harrison, School of Agriculture and Home Economics, Canada; and E. D. Anderson, president of ASAE. G. B. Harrison will preside. There will also be an election of Division officers.

Friday morning, October 25, three concurrent programs will be held. Topics for the Power and Machinery program include some technical aspects of tractor engines and fuels; forage harvesters—history, development, and operation; and salesmanship in agricultural engineering. Election of Division officers will follow. The Soil and Water program will include the discussion of efficiencies of water application by various methods, quality of irrigation water, and a symposium on developments in sprinkler irrigation. Election of Division officers will follow.

The theme of the combined Rural Electric and Farm Structures session will be Electric Heat in Farm Buildings and Homes. L. N. Roberson, L. N. Roberson Co.; H. U. Wright, Washington Water Power Co.; and J. S. Englund, Washington State Institute of Technology, will present papers on fundamental design aspects of electric heat, analysis of electric house heating, and an analysis of heat pump installation, respectively.

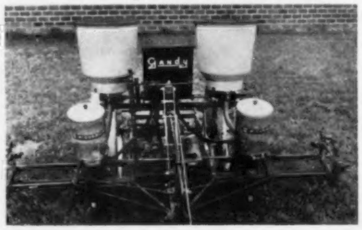
Earl D. Anderson, president of ASAE, will be the speaker for the luncheon Friday noon. The second vice-chairman of the Pacific Northwest Section, D. W. Works, will be toastmaster. Following the luncheon a general session will be held which will cover reports from the Pacific Northwest Section student branches. Student award papers will be given by students from the

(Continued on page 688)

Granular Chemical Equipment

International Harvester Co., has announced that a new granular chemical attachment for McCormick planters and other implements and a broadcast applicator used in the control of insects, nematodes, and weeds will be handled by its dealers.

The granular chemical distributing equipment is designed to combat corn borer, army worms, chinch bugs, grasshoppers, and numerous other pests in the soil, on the sur-



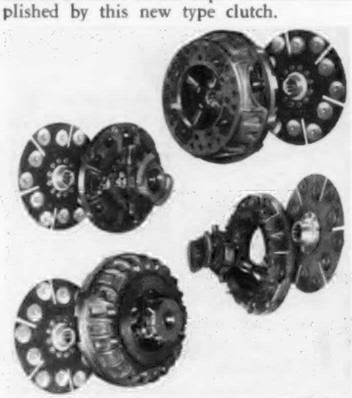
face or on the plants. Attachment and applicator are manufactured by the E. S. Gandrud Co., Inc., Owatonna, Minn.

The granular chemical attachment is for use on 2, 4, and 6-row equipment and the applicator applies chemicals in bands over rows or broadcast over large areas. It is mounted on wheels and has a 12-ft wide hopper that holds 200 lb of granular chemical.

(For more facts circle No. 40 on reply card)

Improved Clutches

Rockford Clutch Div., Borg-Warner Corp., has developed a new clutch arrangement, using friction material with a ceramic base, for use in heavy-duty and off-highway type machines. Increased capacity, better heat disposal, better ventilation, cooler running, no fading, longer wear, fewer adjustments and more usable lining material are said to be some of the improvements accomplished by this new type clutch.



The manufacturer reports that these new clutches and clutch plates provide more than double the torque capacity 4 to 10 times the work life with one-tenth the usual number of adjustments. Clutches are available in both over-center and spring-loaded types in a wide range of sizes up to 18-in, single and double plate, designed and engineered for specific applications.

(For more facts circle No. 19 on reply card)

Earth Moving Unit

Caterpillar Tractor Co., has introduced a new 4-wheel prime mover and matching scraper combination.

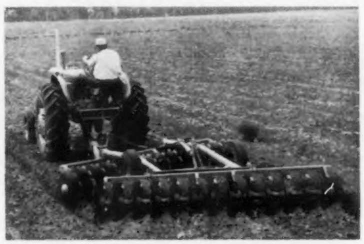
The newly-announced rubber-tired unit is the DW15 (series E) tractor and No. 428 lowbowl scraper. The tractor has a new

diesel engine designed to develop 200 hp (maximum output) at 2000 rpm. Besides offering wide-range torque characteristics, the new tractor has a 10-speed transmission, which offers working speeds from 2.7 to 37.2 mph. The new scraper has a struck capacity of 13 cu yd.

(For more facts circle No. 20 on reply card)

New Offset Disk

The Farm Equipment Division, Allis-Chalmers Mfg. Co., has announced a new 10½-ft hydraulically controlled heavy-duty offset disk harrow. This new implement weighs 2,298 lb and reportedly provides 90 lb of cutting weight for each of its 28 heavy-duty 22-in. blades. It is designed for



turning stubborn soils and for chopping and mixing heavy stalks and other tough residues. Smooth blades are standard. Cutaway disks are available in any desired combination. In addition to the 10½-ft width, the new model is also available in 8½, 9 and 9¾-ft sizes.

(For more facts circle No. 21 on reply card)

New 4-Row Planter

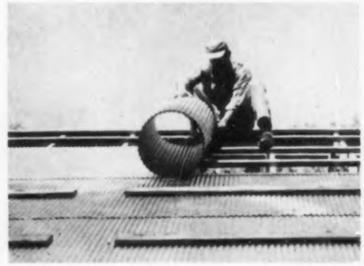
The Tractor and Implement Division of Ford Motor Co., has expanded its line of rear-mounted planting equipment to include a 4-row drill planter designed for large-field planting of corn, beans and many other row crops. The new drill planter can be adjusted to space planted rows from 28 to 42 in. apart.

Both 2-row planting units are designed to "float" independently permitting planters to follow the ground contours regardless of tractor angle. The planter units are attached to a tool bar, which in turn is attached to the tractor by 3-point implement hydraulic linkage.

(For more facts circle No. 39 on reply card)

Roll-On Metal Roofing

Kaiser Aluminum & Chemical Sales, Inc., has introduced a new roll-on roofing and siding. Made of attractively embossed corrugated aluminum in a standard 0.019-in. thickness, the new roofing comes in easy-to-



handle rolls of 50 lineal ft and in widths of 18, 30 and 54 in.

In addition to its uses as a roofing and siding material, the manufacturer lists other applications around the farm and home, such as decorative fencing, fluted concrete forms, light reflectors, wainscoting, house trailer skirting, animal pens, and sun shades.

(For more facts circle No. 23 on reply card)

New Truck Seat

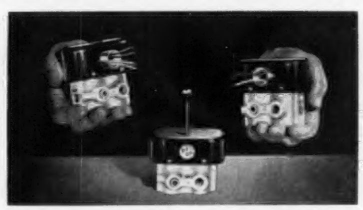
Milsco Mfg. Co., has inaugurated a complete truck seat manufacturing program. One of the first products in the expanded program is the new "Thrift-King" panel truck seat. The new seat features a heavy,

sturdy angle-iron frame, available with or without the pedestal, and with or without fore and aft adjustments. Particular attention has been paid to seat and back cushions to insure driver comfort and reduce fatigue.

(For more facts circle No. 24 on reply card)

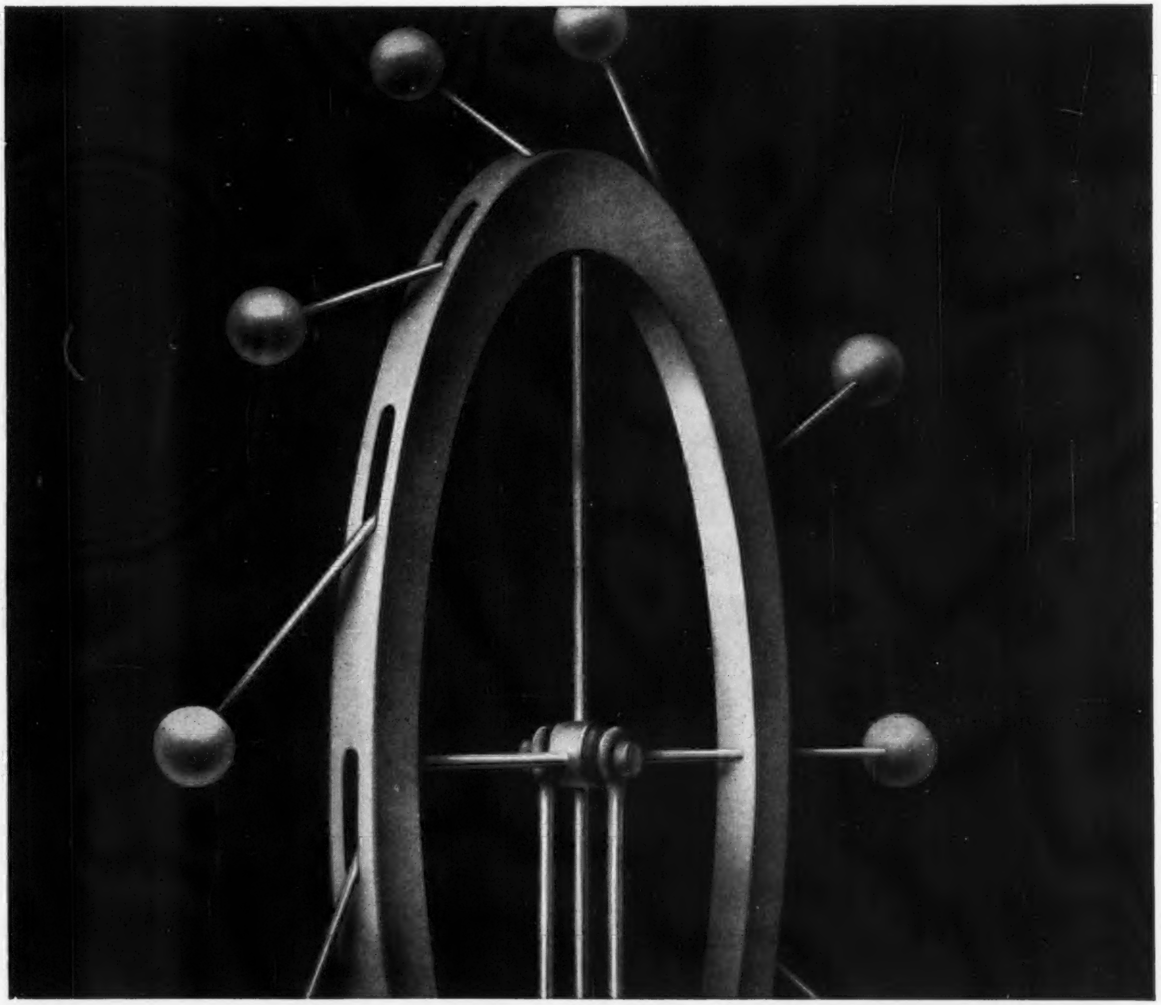
Quick Dump Control Valves

Humphrey Products Div., General Gas Light Co., has developed three new quick-dump control valves for fast smooth operation of double-action cylinders. They are four-way, five-port models with no internal



springs, packings, pistons, or sliding, metal-to-metal contacts. Valving action is said to be fast and positive. Two of the valves are electrically operated and the third is equipped with hand lever.

(For more facts circle No. 25 on reply card)



MANUFACTURERS' LITERATURE

Catalog and Engineering Manual

Aetna Ball and Roller Bearing Co.—This 84-page catalog presents the company's products and the principles governing their selection and application. It is illustrated and indexed. The contents include sections on information about the company itself; the engineering of the products; ball thrust bearings, washers, retainers; mounted ball bearing units; clutch release bearings; roller bearings; special bearings and parts; and general information such as data required for quoting, ordering instructions and location of sales offices.

(For more facts circle No. 44 on reply card)

Poly-V Belt Drives

Raybesto-Manhattan, Inc.—An illustrated 112-page engineering data book for the selection and design of poly-V belt drives. It contains charts, tables and diagrams along with specifications for all drive sizes. Comprehensive data on V-belt drives is included, covering drive tables, horsepower ratings, installation instructions and trouble shooting.

(For more facts circle No. 28 on reply card)

Lubrication Fittings Catalog

Alemite Div., Stewart-Warner Corp. — A 31-page catalog 38-23 of lubrication fittings to be used as a simple, handy guide to fast, easy selection of the right fitting for every requirement. It lists fittings of many types with complete dimensions. In addition it lists many accessories.

(For more facts circle No. 29 on reply card)

Farm Building Bulletins

Armco Drainage & Metal Products, Inc. — A set of six bulletins that describe the first of a new line of the company's steel farm buildings and accessories. They include data on a utility building, utility lean-to, flat steel door, louvered ridge ventilator, tilt-in window, and on farm buildings.

(For more facts circle No. 30 on reply card)

Flexible Couplings

Acme Chain Corp.—An illustrated 8-page brochure CPI-56, containing descriptive information on flexible couplings, together with engineering data, horsepower ratings, parts lists and prices.

(For more facts circle No. 43 on reply card)

Mastitis

Babson Bros. Co.—A booklet on down-to-earth information on the prevention and control of mastitis from a veterinary practitioner's viewpoint. The author bases his findings on years of practice — mostly on dairy farms.

(For more facts circle No. 32 on reply card)

Industrial V-Belts

Durkee-Atwood Co.—A 59-page booklet illustrating and describing the company's V-belts. Included in the contents are sections on the arc of contact, the use of belt dressing, belt types, calculations, comparison charts, correction factors, and other important design and engineering information.

(For more facts circle No. 33 on reply card)

Screw Conveyor Components

Link-Belt Co.—This folder No. 2489 features ball bearing screw conveyor components. Specification charts for trough ends, hangers and conveyor screws are included.

(For more facts circle No. 34 on reply card)

Industrial Wheels

R & K Industrial Products Co.—The company's line of standard aluminum, balloon-cushioned, pressed steel, and micarta wheels is described in the catalog, along with details of design and construction of the R & K Loadmaster wheel. Specifications and uses of various types of bearings, seals and rubber compounds are set forth.

(For more facts circle No. 35 on reply card)

Steel Ball Catalog

New Departure Div. of General Motors Corp. — A 12-page catalog which describes the company's ball production facilities. It contains information concerning ball specification and reports availability of balls made from special materials such as high nickel or cobalt base alloys, tool steel, plastics, nylons, and vacuum melted materials.

(For more facts circle No. 36 on reply card)

Double-Pitch Chain and Sprockets

Diamond Chain Co., Inc.—This Catalog No. 37 contains data on the company's conveying and double-pitch power transmission chain. Standard stock chain and attachments are illustrated and charts are used to provide data for correct selection. Chains to meet special conditions are also included.

(For more facts circle No. 37 on reply card)

Plywood Diaphragms

Douglas Fir Plywood Assn.—This 10-page brochure No. AIA-19-F covers basic facts about diaphragms and diaphragm construction. It includes a description and the uses of diaphragms, also the advantages, and design data. Illustrations and examples are used.

(For more facts circle No. 38 on reply card)

Financial Approach to Industrial Operations, by Alvin Brown. Paper, 5½ x 8½ inches, 23 pages. Published by the Research Division, Society for Advancement of Management, 74 Fifth Ave., New York 11, N. Y. $1.50.

The author shows how the function of financial analysis may facilitate the solution of managerial problems generally. He discusses these problems in fundamental terms and describes the principles governing when to spend, who should make the decision to spend, how the decision should be reached, how much to spend, and how to determine expected returns.

Automobile Repair Manual (twenty-eighth edition), edited by Andrew Grey. Cloth, 9 x 12 inches, illustrated and indexed, 996 pages. Published by Chilton Co., Chestnut and Fifty-Sixth Sts., Philadelphia 39, Pa. $6.95.

A simple, comprehensive guide showing beginners and skilled mechanics alike how to solve repair problems on all automobile models from 1940 to current models. Diagrams and pictures are included showing repairs and adjustments involving motor tune-up, engine overhaul, clutch, brakes, ignition, fuel pump, steering gear, rear, exhaust, distributor, transmission, king pins, windshield wiper, etc.

The book is alphabetically arranged according to unit name or function to aid in locating the information wanted. Included with the manual is a 64-page booklet called "Chilton's Handbook of Automotive Shop Kinks," priced at $1.00.

Federal Farm Law Manual, by Allan E. Korpela. Cloth, 6 x 9 inches, xi + 698 pages, indexed. Published by the Equity Publishing Corp., Oxford, N. H.

This volume is a concise manual covering the large and often complicated mass of federal farm laws. It is said to contain the latest word on the subject, including the Agricultural Act of 1956. It is intended to be a convenient and authoritative guide for the progressive farmer, agricultural scientist, agent, teacher, and student, for processors and manufacturers, and for all who have an interest in the subject of American agriculture.

The book is arranged by topical analysis. Background information is provided wherever it was felt this would facilitate an understanding of the laws. The actual text of the laws, as supplemented by regulations and interpreted by major decisions of the courts constituted the source for the text of the sections.

Grassland Seeds, by W. A. Wheeler and D. D. Hill. Sponsored by the Field Seed Institute of North America and the American Seed Trade Assn. Cloth, 6 x 9 inches, xx + 734 pages, illustrated and indexed. Published by D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. $12.50.

The purpose of this book is to provide, in one volume, a comprehensive source of usable information on all phases of production, processing, handling and marketing of grass and legume seeds for forage, pasture, soil conservation and other turf planting in the United States. It is an excellent reference for students, teachers, county agents, seed growers, seed processors, seed dealers, and any others who are interested in the various phases of the seed industry.

The book is divided into three parts. The first part is devoted to general topics such as seed formation, germination, good stands, testing, insect pollination, harmful insects, diseases, seed treatment, inoculation, harvesting and threshing, seed processing, drying, certification, marketing, international seed trade, estimating seed crops, and the evolution of the seed industry.

The second part deals with the specific grassland crops and their seed problems such as seed traits, habits and characteristics, management of crops for seed production, harvesting, threshing and cleaning of seed, and statistics of seed acreage, yields and production in recent years.

The third part presents available statistical information on the more important seed crops and other essential data on seeds.

. . . Section News

(Continued from page 682)

four student branches in the Section. The annual business meeting will follow and include committee reports and election of officers.

Friday evening, October 25, a banquet will be held with Raymond Muse, Washington State College, as speaker. Saturday morning a tour of Washington State Institute of Technology is planned. In the afternoon there will be a football game with the University of Idaho vs. San Jose State at Moscow, Idaho.

Solve Your Gift Problems

Give something of lasting value, something to inspire and improve, something that will stand out as *YOUR* thoughtful remembrance. GIVE A SUBSCRIPTION TO AGRICULTURAL ENGINEERING to your farmer friends, to your favorite library, to executives interested in engineering or agriculture. Mail the card at the right to place your order. Subscriptions are $5.00 in the USA, $5.50 in Canada, $6.00 elsewhere. ASAE will send a letter to your honoree, in accordance with your instructions, giving details regarding his gift and the name of the donor.

CHECK **GIFT SUBSCRIPTION TO AGRICULTURAL ENGINEERING**

☐ I would like to send a GIFT subscription to AGRICULTURAL ENGINEERING to the person indicated below. I would like the subscription to begin with the ______ issue.

Please write the recipient for me advising that this is a Christmas ______, Birthday ______, other ______ gift. ($5.00 in USA; $5.50 in Canada; $6.00 elsewhere).

My name is ______

Payment enclosed ______ Please invoice me ______

☐ I am an ASAE member and suggest that membership, Including application form be sent to the name and address below.

My name is ______

☐ I would like information about membership in the American Society of Agricultural Engineers including an application form.

Name ______

Position or title ______

Address (☐ Home or ☐ Business) ______

City ______ **Zone** ______ **State** ______

Employed by ______

Use the card *below* for free data on new products and the card *above* for ordering a gift subscription to AGRICULTURAL ENGINEERING or for requesting information about membership in ASAE.

LET US KNOW YOUR WANTS

Do you want more data or other information on products or catalogs advertised or otherwise featured in this issue? Then fill out one of the two mailing cards at the right and drop it in the mail today.

Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

Kindly have mailed to me, without obligation, more information about items in this issue indicated by the numbers circled below:

SEPTEMBER 1957

Please print or type your name, etc., below

Your name ______

Your position or title ______

Name of employer ______

Address of employer ______

City ______ Zone ______ State ______

New Products, New Catalogs, and Advertisements in AGRICULTURAL ENGINEERING

1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98
9	19	29	39	49	59	69	79	89	99
10	20	30	40	50	60	70	80	90	100

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1 **St. Joseph, Mich.**

AGRICULTURAL ENGINEERING

P. O. Box 229

St. Joseph, Michigan

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1 **St. Joseph, Mich.**

American Society of Agricultural Engineers
P.O. Box 229
St. Joseph, Michigan

If you are not a member of the American Society of Agricultural Engineers and want (1) to subscribe* to AGRICULTURAL ENGINEERING or (2) to receive information about ASAE membership—or if you *are* a member of ASAE and want to propose the names of one or more prospective members — then simply fill out and mail the card at the left.

(*NOTE: A subscription to AGRICULTURAL ENGINEERING is included in the annual dues of each ASAE member.)

Use the card *below* for free data on new products and the card *above* for subscribing to AGRICULTURAL ENGINEERING, or for requesting information about membership in the ASAE.

LET US KNOW YOUR WANTS

Postage Will Be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD
First Class Permit No. 1 **St. Joseph, Mich.**

AGRICULTURAL ENGINEERING
P. O. Box 229
St. Joseph, Michigan

Reader Information Service

Do you want more data or other information on products or catalogs advertised or otherwise featured in this issue? Then fill out one of the two mailing cards at the left and drop it in the mail today.

Our "Reader Information Service" clerks will see that your wants are promptly transmitted to sources of materials requested.

Kindly have mailed to me, without obligation, more information about items in this issue indicated by the numbers circled below: **SEPTEMBER 1957**

→ ***Please print or type your name, etc., below*** ←

Your name______________________________

Your position or title______________________________

Name of employer______________________________

Address of employer______________________________

City________________ Zone______ State_______________

New Products, New Catalogs, and Advertisements in AGRICULTURAL ENGINEERING

1	11	21	31	41	51	61	71	81	91
2	12	22	32	42	52	62	72	82	92
3	13	23	33	43	53	63	73	83	93
4	14	24	34	44	54	64	74	84	94
5	15	25	35	45	55	65	75	85	95
6	16	26	36	46	56	66	76	86	96
7	17	27	37	47	57	67	77	87	97
8	18	28	38	48	58	68	78	88	98

St. Joseph, Michigan

8 18 28 38 48 58 68 78 88 98

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Alverson, Howard E.—Mgr., electric power, Southwestern Michigan Rural Elec. Coop., P.O. Box 53, Adrian, Mich.

Avard, Richard F. — Engr., On duty with U.S. Army Corp. Engrs. (Mail) 406 N. Marengo, Alhambra, Calif.

Bauling, Frank W.—Graduate student, University of Illinois (Mail) R.R. 1, Rockton, Ill.

Bloom, Gabriel — Administrative & tech. co-ordinator, Halafim Haklaiim, Ltd., Tel Aviv, Israel (Mail) Shikun Olei America, Herzlia 8, Israel

Boone, Jerry C.—Designer, Allis-Chalmers Mfg. Co., Box 518, Independence, Mo.

Carroll, Robert C. Jr. — Elecn. advisor, Broad River Electric Cooperative, Inc., Gaffney, S. C. (Mail) R.R. 4, Box 86-C.

Choate, Charles P.—Student engr., Southern Bell Telephone & Telegraph Co., Jacksonville, Fla. (Mail) 416 Aiken Rd.

Cornett, Mike W.—Ind. engr., United States Steel Corp., Gary, Ind. (Mail) 440 Grant St.

Dugger, Roy W.—Asst. prof., agr. education, Oklahoma A and M College, Stillwater, Okla.

Fairbairn, Frederick W. — (Mail) R.R., Ridott, Ill.

Gay, Lawrence H.—Engr.-in-training, John Deere Spreader Works, East Moline, Ill. (Mail) 1930 3rd St.

Gustafson, John W.—Elec. use advisor, Co-Op. Electric Co., St. Ansgar, Iowa, (Mail) P.O. Box 295

Hall, Alfred D.—Irrigation officer, New Zealand Dept. of Agriculture, P.O. Box 52, Ashburton, Canterbury, N. Z.

Head, Sam D. — Mgr., branch office, John Deere Plow Company, 2205 E. 26th St., Little Rock, Ark.

Henry, Ralph T.—Field rep., Factory Insurance Assn., Atlanta, Ga. (Mail) R.R. 7, P.O. Box 167, Roanoke, Va.

Jenkins, George Jr.—Ext. specialist, agr. eng. dept., University of Kentucky, Lexington, Ky.

Jensen, Harlan P. — Engr., John Deere Waterloo Tractor Works, Waterloo, Ia. (Mail) 433 Vermont St.

Johnson, Eugene K.—Agr. engr., (ARS), USDA, Beltsville, Md. (Mail) 7404 Hopkins Ave., College Park, Md.

Jordin, Donald L.—Farm sales supervisor, Washington Water Power Co., Spokane, Wash.

Kiffer, D. A. — Chief engr., Chamberlain Corp., Mildred St., Waterloo, Iowa

Kleven, Roy J.—Farmer, R.R., Weldon, Ill.

Kubik, Harold E.—Jr. engr., Kansas Water Resources Board, State Bldg., Topeka, Kans. (Mail) 1212 Tyler

Ligon, James A.—Graduate asst., agr. eng. dept., Iowa State College, Ames, Ia. (Mail) R.R. 2, Easley, S. C.

McVay, Paul G. — Gen. supervisor, farm tools div., Pittsburgh Forgings Co., Coraopolis, Pa., (Mail) 43 Silver Lane

Monteith, John III — Agr. engr., (SCS), USDA, Longmont, Colo. (Mail) c/o J. Monteith, Jr., 1035 N. Logan Ave., Colorado Springs, Colo.

Paul, Maurice L.—Res. asst., agr. eng. dept., University of Illinois, Urbana.

Prescott, Robert D.—Graduate trainee, Ford Motor Company, Dearborn, Mich. (Mail) Shaw's Ridge, Sanford, Maine

Quattrini, Federico — Mgr., La Comercial Importadora, Avda Bolognesi No. 125, Lima Peru, S. A.

Raymond, Charles F.—Maintenance supervisor, Mobile Acres Trailer Park & Sales, R.R. 2, Wellsburg, N. Y.

Roberts, Wayne E. — Engr. trainee, Caterpillar Tractor Co., Peoria, Ill. (Mail) R.R. 3, P.O. Box 147, Parma, Idaho

Rowe, Richard J. — Agr. engr., (AERD, ARS), USDA, Iowa State College, Ames Ia. (Mail) 384 Pammel Ct.

Schmidlapp, William L. — Educational advisor, Pioneer Rural Electric Co-Operative, Piqua, Ohio (Mail) 115 Harrison St., Covington

Schwartz, Wayne E. — Engr's. asst., Allis-Chalmers Mfg. Co., Milwaukee, Wis. (Mail) 2560 Wauwatosa Ave., Wauwatosa 13

Stone, Charles L. — Mgr., loading div., Howry-Berg Steel & Iron Works, Inc., 1366 W. Oxford St., Englewood, Colo. (Mail) 8045 W. 46th Circle, Wheat Ridge

(Continued on page 697)

Transportation of Large Quantities of Water for Fire Fighting Over Rough Terrain, by John F. Christian, engineering research and development laboratory, U.S. Army, Fort Belvoir, Va. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a special Soil and Water Program for Public Lands and Public Works. Paper No. **PL-2.**

Mass fires, whether in urban areas or forest and wild lands, create abnormal demands for water for fire fighting. The involved areas will be impassable to vehicles because of debris in the streets or the roughness of the terrain. The author reports that a solution to the problem is a high capacity, low pressure, expendable, emergency water supply system transported and laid by helicopter developed by the U.S. Army Engineer Research and Development Laboratories. The system is made up of 500-ft lengths of 8-in. diameter hose in flaking boxes, and submersible electrically-driven pumps with trailer mounted engine generator sets. The pump, with hose and power cable attached, can be carried by helicopter across tidal flats or swamps to draftable water. The trailer mounted engine generator would remain on the shore. The method is explained and discussed in this paper.

Minimum Water Requirements of Grasses, by Wayne D. Criddle, state engineer, Salt Lake City, Utah. Paper presented at the Golden Anniversary meeting of ASAE in East Lansing, Mich., June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-20.**

The author suggests criteria that might be used in determining use rates under various growth requirement conditions since minimum water requirements vary with climate, species and density of grasses and soils. The paper discusses rates of water use under different conditions — rates of water use by a relatively dense grass cover will be rather high immediately following an irrigation or a rain. However, it is pointed out that as the soil dries out, the rate of use might drop rather low.

The average use rate, as stated by the author, for the hot periods will be in the range of 0.12 to 0.18-in per day depending on the climatic zone. The lower figures are suggested for the humid coastal zones and the higher are for the hot interior valleys. Such figures are subject to variation dependent upon how much growth is desired.

Regional Selection of Grasses, by Burton F. Kiltz, Office of the Chief of Engineers, U.S. Army, Washington, D.C. Paper presented at the Golden Anniversary Meeting of ASAE in East Lansing, Mich., June, 1957, on a special Soil and Water Program for Public Lands and Public Works. Paper No. **PL-10.**

The paper furnishes a brief description of the principal consecutive steps required in establishing grasses on improved military grounds. The author states that military installations may not have individuals who are capable of supervising such plantings, therefore, it is necessary that the instructions they follow are concise and have a minimum number of exceptions and variations.

The United States has been divided into zones for determining the grass to use. The limitations of the grasses selected are discussed. Substitute grasses are listed in each zone where it is anticipated that they are needed. Simplified instructions of this kind are not substitutes for technical guidance but serve to provide a satisfactory planting schedule where specialists cannot be obtained.

Bulk Milk Cooler Heats Water, by M. C. Ahrens, assistant agricultural engineer, ARS, USDA, State College of Washington, Pullman. Paper presented at the Golden Anniversary meeting of ASAE in East Lansing, June, 1957, on a program arranged by the Electric Power and Processing Division. Paper No. **57-58.**

This paper reports on work performed to determine the feasibility of the heat pump application of the bulk-tank milk cooler to pre-heat water. Laboratory results indicate savings can be made by using the heat energy removed in the cooling process. A direct expansion bulk milk tank is used to cool milk and to pre-heat the water normally heated by a water heater. Using a 400-gal tank with a 2-hp compressor, savings of 4,000 kw-hr per year were obtained by pre-heating water to 120 F from a supply temperature of 55 F with 50 gal of wash water used after each milking.

It was also found that fewer kw-hr were required to cool 100 gal of milk substitute using the heat pump method while also heating 42 gal of water to 120 F than with the conventional air-cooled condenser in an ambient temperature of 76 F or above.

Hydrologic Surveys, by Frank P. Erichsen, hydraulic engineer, SCS, USDA, Milwaukee, Wis. Paper presented at the Golden Anniversary meeting of ASAE at Michigan State University, East Lansing, June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-35.**

Hydrologic surveys and analyses for the upstream watershed protection and flood prevention program of the Soil Conservation Service are discussed in this paper. The significance of various factors affecting the relation between rainfall and runoff are presented. Reference is made to the Hydrology Guide recently developed by the SCS to be used for analysis of the hydrologic features of a watershed and for development of hydrographs, flood routing, frequency determinations, and other related hydrologic subjects. The role of the hydrologist in developing a watershed plan for upstream flood protection is discussed.

New Developments in Forest Fire Fighting Equipment, by Ira C. Funk, chief, Fire Equipment and Aeronautics, U.S. Forest Service, Washington, D. C. Paper presented at the Golden Anniversary meeting of ASAE in East Lansing, Mich., June, 1957, on a special program arranged by the Soil and Water Division for Public Lands and Public Works. Paper No. **PL-1.**

This paper describes recent developments including design problems and testing of fire fighting equipment for grass, brush, and timbered areas. Some of the items included are self-propelled, gasoline-powered, fireline-trenching and scraping machines; improved tractor-drawn fireline plows and transports; apparatus and procedures for testing spark arresters, for gasoline and diesel engine-driven equipment; pumper-tanker fire apparatus for various-sized vehicles; equipment for mixing and handling fire retardants such as sodium calcium borate; tanks, discharge system and controls for cascading liquid fire retardants from agricultural airplanes, helicopters, and torpedo bombers; fire hose dispensing equipment and tanks for light helicopters; and improved steerable parachutes.

AMES ABC SPRINKLER SYSTEMS, with the famous Ames Ball Coupler, are the most modern, economical revolving sprinkler systems on the market. Quickly converted to Tow-A-Line or Wheel-O-Rain mechanical move systems.

ONLY AMES offers a complete line of irrigation equipment for all irrigation methods: sprinkler, furrow and flood. Backed by factory guarantees and service, and installation "profit-planning"—locally and nationally—since 1910. Write for details.

AMES

"Profit-Planned" IRRIGATION SYSTEMS

W. R. AMES CO.

150 HOOPER STREET • SAN FRANCISCO 7, CALIF.

Since 1910 Denver · Indianapolis · Tampa · Sydney, Australia

For more facts circle No. 4 on reply card

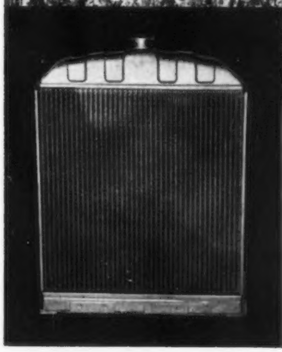
SOLVE your GIFT PROBLEMS

Give something of lasting value, something to inspire and improve, something that will stand out as *YOUR* thoughtful remembrance.

GIVE A SUBSCRIPTION TO AGRICULTURAL ENGINEERING to your farmer friends, to your favorite library, to executives interested in engineering or agriculture. Use the tear-away card on the insert to place your order. Subscriptions are $5.00 in the USA, $5.50 in Canada, $6.00 elsewhere.

ASAE will send a letter to your honoree, in accordance with your instructions, giving details regarding his gift and the name of donor.

HARVESTING MAIZE IN TEXAS IS A HOT JOB FOR MAN OR MACHINE!



but heat can't stop the Super 100 ALL-CROP Harvester, built by Allis-Chalmers, because . . .

Young RADIATORS provide dependable cooling

Crop harvesting in Texas, or elsewhere, makes heavy performance demands on equipment. Young Radiators meet or exceed any demands put upon them, and provide consistently dependable cooling under the most extreme conditions.

Young Engineering can design the radiator to solve your Heat Transfer problem.

YOUNG RADIATORS ARE USED WHERE THE GOING IS TOUGH

Write today to Department 297-J for Catalog 148-A. Your enquiry is welcome and there is no obligation.

Young RADIATOR COMPANY

RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

For more facts circle No. 5 on reply card

PERSONNEL SERVICE BULLETIN

NOTE: In this bulletin the following listings current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated. "Agricultural Engineer" as used in these listings is not intended to imply any specific level of proficiency or registration as a professional engineer. Items published herein are summaries of mimeographed listings carried in the Personnel Service, copies of which will be furnished on request. To be listed in this Bulletin, request form for Personnel Service listings.

POSITIONS OPEN—JANUARY—O-8-701. FEBRUARY — O-14-702, 14-703, 23-704, 23-705, 23-706, 12-707, 28-708. MARCH — O-21-710, 52-711, 60-712, 81-715, 84-716, 70-717. APRIL —O-90-718. MAY—O-154-721, 154-722, 155-723, 165-725, 99-727. JUNE — O-179-728, 189-729, 170-730. JULY—O-231-732. AUGUST—O-183-734, 196-735, 248-736, 255-737, 259-738, 265-739.

POSITIONS WANTED — FEBRUARY—W-33-2, 10-3. APRIL—W-68-5, 74-6. MAY—W-51-7, 96-8, 128-9. JUNE—W-186-11, 171-12, 180-13, 190-14. JULY — W-193-15, 192-16, 238-17. AUGUST — W-206-18, 247-20, 216-21, 254-22, 239-23, 242-24, 256-25, 261-26.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER to head extension specialists' group in agricultural engineering department of a southern university. MSAE or higher degree. Extension experience desirable. Ability to organize and direct extension programs. Salary open. O-267-741

AGRICULTURAL ENGINEER, assistant professor rank, for teaching and research in rural electrification in a southern university. Ph.D. or MSAE. Some research experience in rural electrification. Ability to organize and conduct research projects. Well-equipped laboratory facilities. Salary open. O-267-742

AGRICULTURAL ENGINEER, assistant professor rank, for teaching and research in soil and water field in a southern university. MSAE or BSAE with experience. Salary open. O-267-743

GRADUATE ASSISTANT in agricultural engineering for half-time research in effects of electromagnetic radiation on seeds and plants, at a southern university. Can carry two-thirds of full-time study program. Excellent instrumentation and equipment available. Salary $2,000 plus remission of fees. O-267-744

AGRICULTURAL ENGINEER for farm power engineering work with electric utility in Midwest. Promote sale of electric service to farm customers; provide engineering guidance on service and application problems; investigate and adjust complaints. Age 25 or over. BSAE with emphasis on electrification, or equivalent. Pleasing personality, realistic judgment and approach to problems, ability to meet the public and act courteously and tactfully in handling the necessary problems. Good opportunity for advancement. Salary open. O-281-745

AGRICULTURAL ENGINEER, electrification advisor for electric cooperative in Southwest. Age 35-45. College graduate with one or two years experience in power use promotion. Salary, $5,000 or higher. O-292-746

ENGINEER for testing and research work on tractors, engines and component parts for a Midwest tractor and implement company. Must have sound basic engineering training, a thorough understanding of thermodynamics, mechanics and strength of materials. Must be acquainted with engine and transmission testing procedures. Degree in agricultural or mechanical engineering. Salary open. 0-264-747

ENGINEER for testing and research work in stress analysis field with a Midwest tractor and farm machinery company. Must have basic knowledge of electronics, applied mechanics, metallurgy, use of stress analysis equipment and an understanding of functions of farm machinery. Degree in agricultural or mechanical engineering. Salary open. 0-264-748

NEW POSITIONS WANTED

AGRICULTURAL ENGINEER for service, writing or management in power and machinery, soil and water, or farm management, with manufacturer, consultant or farming operation, anywhere in USA or Latin America. Married. Age 40. No disability. BSAE, 1939, Oregon State College. Experience as soil surveyor with USDA 3 years. In charge of soil surveys, Ministry of Agriculture, Venezuela, 3 years. Technical director, Turin Agricultural Colony, Venezuela, 3 years. Technical advisor, Venezuelan Development Corporation, 3 years. Own and operate farm in Venezuela and do some consulting work, since 1953. War commissioned service in Navy. Available now. Salary open. W-278-27

AGRICULTURAL ENGINEER for extension, teaching, or research in soil and water field with public service or industry, preferably in Southeast. Married. Age 24. No disability. BSAE, 1940, University of Georgia. Farm background. Part time research, University of Georgia. Topographic surveying one year. USAF Commissioned service, pilot, 3 years. Available now. Salary $6,000. W-276-28

AGRICULTURAL ENGINEER for design, development, research, writing, and management, in power and machinery, soil and water, product processing, or agricultural development, with manufacturer, processor, consultant or farming operation. Any location. Married. Age 57. No disability. Professional engineering training, University of Toronto. Experience 20 years in design and production of small electromechanical devices; 10 years in clearing, development, and management of large agricultural production operations in Africa, including research in all phases of agricultural engineering. Commissioned war service in Canadian Army Signal Corps. Available in 1958 or possibly earlier. Available for interview in New York later this year. Salary open. W-262-29

AGRICULTURAL ENGINEER for research, service, or writing, in power and machinery field with manufacturer, trade association or agricultural extension service, preferably in Midwest. Married. Age 31. No disability. BSAE, 1951, Kansas State College. Farm background. Self-employed farmer, 1943-47. Part-time farming during college. Technical writing, service of farm tractors and associated implements 1953-54. Regional service supervisor for farm tractor company 1954-57. Product planning analysis with manufacturer several months. Commissioned service, 1951-1953. Available on reasonable notice. Salary open. W-288-30

AGRICULTURAL ENGINEER for design, development, or management, in power and machinery with manufacturer or consultant, preferably in Midwest. Married. No disability. BSAE, 1939. Progressive responsibility from product design through chief engineer and plant management, mostly in farm equipment field. Available September 15. Salary $15,000-20,000. W-296-31

AGRICULTURAL ENGINEER for design, development, research or writing, in power and machinery or soil and water field, with public service. Special interest in animal-drawn small implements, and in farm product processing. Prefer Southeast, but will consider other locations or foreign service. Married. Age 63. No disability. BSA, 1919; BSAE, 1921; AE, 1928, University of Missouri. Experience 35 years in mission teaching, research and administration in India, including development of professional agricultural engineering curriculum. Established and managed factory for manufacture of implements, 4 years. Available July 1, 1958, or earlier. Salary open. W-286-32

AGRICULTURAL ENGINEER for product planning, design or development in power and machinery with manufacturer or processor. Any location. Married. Age 35. BSAE, 1949, University of Minnesota. Farm background. Experience 3½ years as only engineer with small manufacturer of farm equipment; 1½ years as research engineer with food processor. Product planning analyst 3 years with large manufacturer of farm equipment. War enlisted service 4 years in Air Force as aircraft mechanic and instructor in aircraft mechanic school. Available on 30 days notice. Salary $8,500. W-299-33

AGRICULTURAL ENGINEER for research, and design, or consumer contact, liaison and report writing in power and machinery field, with manufacturer or processor, preferably in Midwest. Married. Age 30. No disability. BSAE, 1951; MSAE, expected December 1957, University of Minnesota. Field testing, design and liaison with major farm equipment manufacturer 3 years. Design engineering and design supervision with component manufacturer 2 years. Research assistant and graduate student one year. War enlisted service in Navy 2 years. Available January 1. Salary open. W-290-34

Three Elected ASAE Fellows

The Council of ASAE recently elected W. D. Ellison, J. H. Lillard, Jr. and D. E. Wiant to the grade of Fellow in the Society.

Walter D. Ellison has been a leader in agricultural engineering work for over 30 years and a member of ASAE since 1928. He was born in 1898 at Bunceton, Mo. He graduated in 1926 from Montana State College with a B.S. degree in civil engineering. Following graduation he was employed by the research division of agricultural engineering with the U.S. Department of Agriculture. The results of his early drainage investigations are still used by drainage engineers. In 1933 he was placed in charge of the engineering activities of the first Civilian Conservation Corps camps in the southern region of the United States and was instrumental in establishing efficient working programs.

As the first project supervisor of the Coshocton Watershed Project established in Ohio by the Department of Agriculture in 1936, he directed and supervised the installation of a large variety of scientific instruments employed in conducting comprehensive experiments in the fields of hydraulics, hydrology, meteorology, forestry, soils, agronomy and agricultural engineering as related to flood control and soil and water conservation. The research work Mr. Ellison initiated and conducted at this station is now recognized and used worldwide, particularly his raindrop splash erosion theory.

He became soil conservation and erosion control consultant for the Navy in 1949. He has developed and established a well integrated and basically sound soil conservation program on naval installations in this country and abroad. His work with the Navy has resulted in many acres of their lands being placed under effective soil and water conservation control.

Mr. Ellison is said to possess a combination of technical competence and executive talent. He knows how a job should be done and how to get it done.

James H. Lillard, Jr. is known for his numerous and valuable contributions to the science and practice of good conservation farming methods. He joined ASAE in 1933 and has served on various technical committees of the Society and is past vice-chairman of the Virginia and the Southeastern Sections.

Mr. Lillard was born at Madison, Va., in 1911. He received B.S. and M.S. degrees in agricultural engineering in 1932 and 1933, respectively, from Virginia Polytechnic Institute. Following graduation he was assistant and project agricultural engineer for Soil Conservation Service projects in Virginia and West Virginia. In 1936 he returned to VPI as assistant agricultural engineer and was responsible for developing and conducting research projects in hydrology erosion control, water conservation research projects for the Virginia Agricultural Experiment Station.

At present he is agricultural engineer of the Virginia Agricultural Experiment Station and leader, research division, agricultural engineering dept., VPI, with leader responsibilities for all soil and water conservation projects. His work also includes projects in farm structures, rural electrification and products processing. During the war he continued his engineering profession by working in the General Engineering Laboratory of the U.S. Army Signal Corps.

He is an active member of the National Society of Professional Engineers, and is a member of the state board of directors of the Virginia Society of Professional Engineers. Through these and other activities he helps promote and endorse the agricultural engineering profession. He has been author or co-author of publications and technical papers connected with various engineering phases of soil and water conservation.

Dennis E. Wiant has been an active member of the Society since 1929. His principal experience has been in educational work but he has also had some experience with both the Ford Motor Co. and the International Harvester Co. as tractor road man and salesman, respectively.

He was born in 1895 at Huntington Mills, Pa. In 1916 he graduated from the Bloomsburg State Teachers College, in 1924 he received a B.S. degree in agricultural engineering from Iowa State College, and an M.S. degree in agricultural engineering from Kansas State College in 1939.

Mr. Wiant was principal of the Ward School in Clearfield, Pa., for one year, and instructor and assistant professor of agricultural engineering at South Dakota State College from 1928 to 1939. He was a graduate assistant at Kansas State College in 1937-1938, and in 1939 he accepted the position of professor of agricultural engineering at Michigan State University, which he still holds.

He has written articles covering research work in which he was involved, many of which appeared in AGRICULTURAL ENGINEERING. He was vice-chairman of the ASAE Michigan Section in 1947-1948 and chairman of the Rural Electric Division of ASAE in 1950-1951. He has been chairman of the Michigan Committee on Rural Electrification for many years. At the present time he is collaborating with two other men on completing a text book on electricity for the Ferguson series in agricultural engineering.

. . . Membership Applicants

(Continued from page 692)

Titus, Louis—Prof. and engr., University of Nevada, Extension Div., Reno, Nevada

Turnquist, Paul K.—Res. engr., Caterpillar Tractor Co., Peoria, Ill. (Mail) R.R. 2, Lindsborg, Kans.

Wadsworth, James D. — Ext. agr. engr., agr. eng. dept., Utah State University, Logan, Utah (Mail) 1353 Canyon Rd.

Waelti, Henry — Engr.-in-training, John Deere Co., Moline, Ill.

Wright, Harold C. — Patent examiner, U.S. Patent Office, Washington, D. C. (Mail) 2417 Davis Ave., Braddock Heights, Alexandria, Va.

Zink, Phillip L. — Graduate trainee, Ford Motor Co., Tractor & Implement Div., Birmingham, Mich. (Mail) 2409 Oakshire Drive, Berkley

Transfer of Membership

Clevenger, Hayden L. — Reg. sales mgr., Food Machinery & Chemical Corp., Fairway Ave., Lakeland, Fla. (Mail) P.O. Box 1718. (Associate Member to Member)

Huntington, David H.—Assoc. prof. of agr. eng., University of Maine, Orono, Me. (Mail) 11 Winslow Hall, University of Maine. (Associate Member to Member)

Talenti, Pier F.—Asst. cashier, First Western Bank & Trust Co., 405 Montgomery St., San Francisco, Calif. (Associate Member to Member)

Index to Advertisers

ADVERTISING REPRESENTATIVES

Chicago: DWIGHT EARLY & SONS, 100 North La Salle St. (Telephone: CEntral 6-2184)

New York: BILLINGSLEA & FICKE, 420 Lexington Ave. (Telephone: LExington 2-3667)

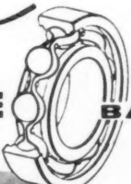
Los Angeles: JUSTIN HANNON, 635 Kenmore Ave. (Telephone: DUnkirk 5-3993)

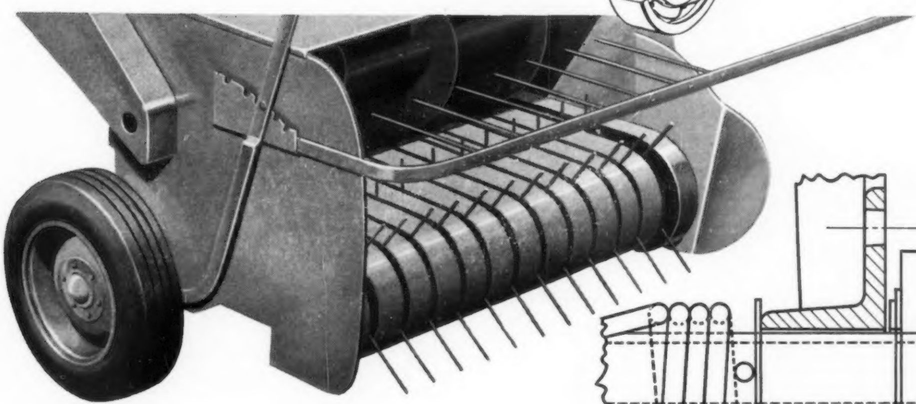
Advertising Manager: RAYMOND OLNEY, 420 Main St., St. Joseph, Mich. (Telephone: YUkon 3-2700)

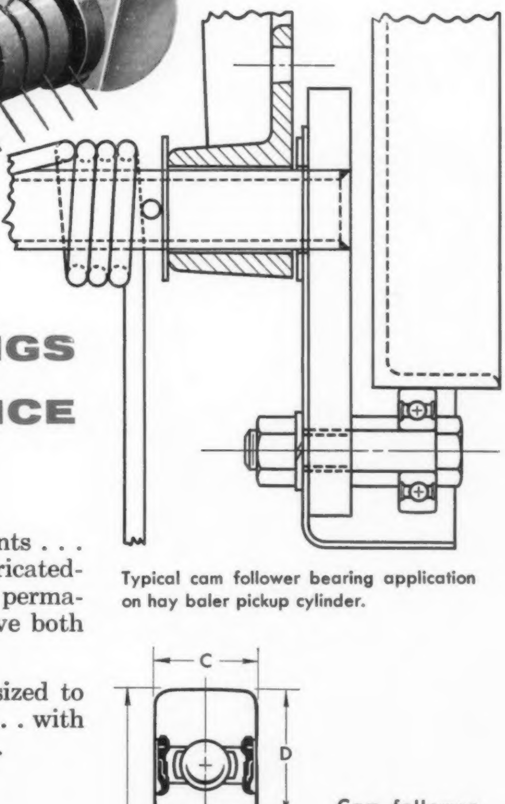
FACTS

about

NEW DEPARTURE BALL BEARINGS







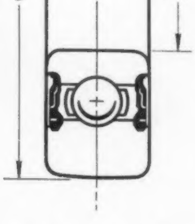
Typical cam follower bearing application on hay baler pickup cylinder.

CAM FOLLOWER BEARINGS REQUIRE NO MAINTENANCE IN HAY BALER

Add *savings* to the sales appeal of your farm implements . . . with New Departure sealed ball bearings. They're lubricated-for-life with a high-quality, water-resistant grease . . . permanently protected by extremely efficient seals. They save both *time* and *money* for farmers.

But that's not all! These New Departures have bores sized to mount on standard bolts for lowest-cost assemblies . . . with no provision necessary for adjustment or relubrication.

Send for New Departure Farm Implement Catalog, FIC-A.



Cam follower bearings have crowned outside diameters, and the outer rings are of extra-heavy section for resistance to shock.

SPECIFICATIONS

Bearing Number	Mounting Bolt Dia. A	O.D. B	Width C	Crown Radius D
CF2-108	½	1.500	.433	3.000
*CF2-108A	½	1.500	.433	3.000
CF3-200	⅝	2.000	.505	4.000
*CF3-200A	⅝	2.000	.505	4.000

*Equipped with inexpensive plastic seals.

BALL BEARINGS MAKE GOOD PRODUCTS BETTER

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

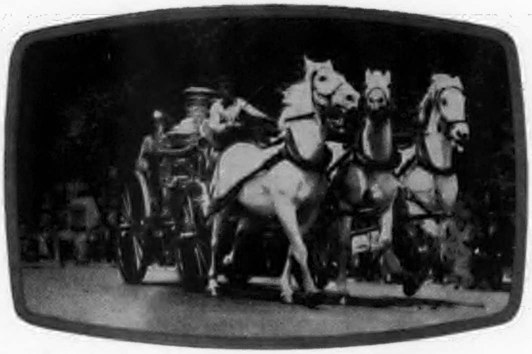
For more facts circle No. 52 on reply card

SEE TIMKEN TELEVENTS ON NETWORK TV

Two big hour-long spectaculars this fall

Over 126 NBC STATIONS, SEPTEMBER 23rd

"Eleven Against the Ice", the story of the Antarctica Turnpike. See men and machines build a trail across Antarctica's frozen wastes—in spite of 200 mph winds, temperatures of 120 degrees below zero and crevasses big enough to swallow a 20-story building. It's a triumph of engineering and human courage, a whale of a television show.

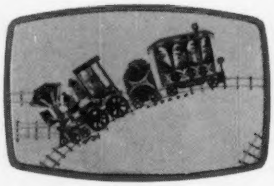


Over 142 NBC STATIONS, NOVEMBER 21st

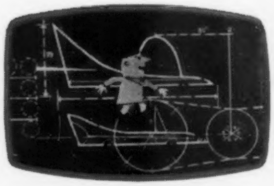
"The Innocent Years". Recaptured from exciting old films and newsreels, you'll see happy days relived. Experience the excitement of "Teddy" Roosevelt, Thomas Edison and Mark Twain in action. Hear songs like: "In the Good Old Summertime", "He'd Have to Get Out and Get Under". Enjoy the fun of family picnics, the joys of people in the last untroubled time in our history.

And commercials that help you sell . . .

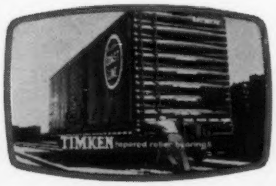
See How man stumbled on the concept of the wheel.



See Why America's railroads have always led the world.



See Why Americans jump for the latest thing in cars.



See One man push a freight car all by himself.

Years of national and trade advertising, backed by their superior performance, have made "Timken" the best-known name in bearings—a name that helps to sell the products that use Timken® bearings. Now, network television will build even a greater awareness of Timken bearings—make them an even bigger sales plus in the equipment you sell. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN TAPERED ROLLER BEARINGS

TRADE-MARK REG. U. S. PAT. OFF.

For more facts circle No. 65 on reply card